

SOIL SURVEY

Montour and Northumberland Counties Pennsylvania



Series 1942, No. 11

Issued September, 1955

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service

In cooperation with the

PENNSYLVANIA STATE UNIVERSITY

COLLEGE OF AGRICULTURE AND EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have worked with their soils for a long time know about differences among the soils on their own farms and those of their immediate neighbors. What they do not know, unless soil surveys have been made, is how nearly their soils are like those on experiment stations or in other localities where farmers have gained experience with new practices or enterprises. Farmers of Montour and Northumberland Counties can avoid some of the risk involved in trying new crop and soil management practices by using this soil report, for it maps and describes the soils of the two counties and therefore allows them to compare soils on their farms with soils on which new developments have been successful.

SOILS OF A PARTICULAR FARM

All the soils of Montour and Northumberland Counties are shown on the map that accompanies this report. To learn what soils are on a farm (or any tract of land) it is first necessary to locate its boundaries on the map. Roads, streams, villages, dwellings, and other landmarks will assist in this. Remember that an inch on the map equals about four-tenths of a mile on the ground.

The next step is to identify the soils on the farm. Suppose, for example, one finds on a farm an area marked with the symbol MA. Look among the rectangles in the margin of the map and find one with MA printed on it. Just below this rectangle is the name of the soil—Mazeppa silt loam. All areas of this soil, wherever they occur on the map, are marked with the same symbol and shown in the same color.

What is Mazeppa silt loam like, for what is it used, and to what uses is it suited? For this information turn to the section on Descriptions of the Soils. How productive is this soil? The answer will be found in table 14. Find Mazeppa silt loam in the left-hand column of this table and note in the columns opposite the yields of different crops it can be expected to produce. Compare

these yields with those given in the table for other soils of the counties.

What uses and management practices are recommended for Mazeppa silt loam? For this information read what is said about this soil in the section on Descriptions of the Soils. Refer also to the subsection on Soil Management Groups, in which soils having about the same management needs are grouped together. It will be found that Mazeppa silt loam is in management group 1A. What is said about crop rotations, fertilization, liming, drainage, and other management practices for that group will apply to Mazeppa silt loam.

SOILS OF THE AREA AS A WHOLE

A general idea of the soils of the two counties is given in the introductory part of the section on Soils, which tells about the principal kinds of soils, where they are found, and how they are related. After reading this part, study the soil map and notice how different kinds of soils tend to be arranged in different parts of the county. These patterns are likely to be associated with well-recognized differences in type of farming, land use, and land use problems.

A newcomer to the area, especially if he considers purchasing a farm, will want to know about the climate; the types and sizes of farms; the principal farm products and how they are marketed; the kinds and conditions of tenancy; farm buildings, equipment, and machinery; availability of churches, schools, roads, railroads, and water supplies; industries; in the area; and population. Information about all these will be found in the section on General Nature of the Area and the section on Agriculture.

Those interested in how the soils of the county were formed and how they are related to the great soil groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of Montour and Northumberland Counties, Pa., is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

and the

PENNSYLVANIA STATE UNIVERSITY

COLLEGE OF AGRICULTURE AND EXPERIMENT STATION

SOIL SURVEY OF MONTOUR AND NORTHUMBER- LAND COUNTIES, PENNSYLVANIA

By DAVID TAYLOR, Soil Conservation Service, in Charge; S. R. BACON,¹ Soil Survey,²
United States Department of Agriculture, and L. G. YEARICK, Pennsylvania State University

Area inspected by W. J. LATIMER, Soil Scientist

United States Department of Agriculture in cooperation with the Pennsylvania State University
College of Agriculture and Experiment Station

CONTENTS

	Page		Page
General nature of the area.....	4	Soils—Continued	
Location and extent.....	4	Descriptions of the soils—Con.	
Physiography, relief, and drainage.....	4	Chenango sandy loam.....	37
Climate.....	6	Chillisquaque silt loam.....	37
Water supply.....	8	Chilo loam.....	38
Vegetation.....	8	Comly silt loam:	
Early history and population.....	9	Eroded phase.....	39
Transportation facilities, schools, churches, and hospitals.....	10	Eroded sloping phase.....	39
Industrial development.....	10	Crestmore silt loam.....	40
Agriculture.....	11	Eroded hilly phase.....	40
Crops.....	11	Eroded sloping phase.....	41
Livestock and livestock products.....	13	Dewart gravelly silt loam.....	41
Land use.....	13	Eroded rolling phase.....	42
Farm tenure.....	14	Dewart sandy loam, eroded phase.....	43
Farm power and equipment.....	14	Dewart silt loam.....	43
Types and sizes of farms.....	14	Dubois silt loam.....	43
Soil survey methods and definitions.....	15	Dunning silty clay loam.....	44
Soils.....	17	Elkinsville silt loam.....	45
Soils in relation to geology.....	17	Elliber cherty silt loam.....	45
Soils series and their relations.....	18	Hill phase.....	46
Soils of uplands.....	19	Rolling phase.....	46
Soils of terraces.....	25	Fleetwood channery loam, shallow phase.....	47
Soils of bottom lands.....	26	Fleetwood stony loam.....	47
Miscellaneous land types.....	27	Gently rolling phase.....	48
Descriptions of the soils.....	27	Hilly phase.....	48
Allenwood gravelly silt loam.....	30	Shallow phase.....	48
Eroded rolling phase.....	31	Ginat sandy loam.....	48
Allenwood silt loam.....	31	Ginat silt loam.....	49
Eroded phase.....	32	Hagerstown silt loam:	
Eroded rolling phase.....	32	Eroded hill shallow phase.....	49
Alvira silt loam.....	32	Eroded shallow phase.....	50
Ashton fine sandy loam.....	33	Eroded sloping shallow phase.....	50
Ashton silt loam.....	34	Hartleton channery silt loam.....	51
Bartle silt loam.....	35	Eroded hilly phase.....	52
Buchanan stony loam.....	36	Eroded phase.....	52
Chenango gravelly loam.....	36	Eroded rolling phase.....	52
		Hilly phase.....	52

¹ Report written by S. R. Bacon.

² Field work for this survey was done while the Division of Soil Survey was a part of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration. The Division was transferred to the Soil Conservation Service on November 15, 1952.

Soils—Continued	Page	Soils—Continued	Page
Descriptions of the soils—Con.		Descriptions of the soils—Con.	
Holly silt loam.....	53	Norton gravelly loam.....	78
Huntington sandy loam.....	53	Eroded phase.....	79
Huntington silt loam.....	54	Eroded sloping phase.....	79
Kistler shaly silt loam.....	55	Sloping phase.....	79
Eroded hilly phase.....	55	Norton silt loam.....	80
Eroded phase.....	56	Eroded phase.....	80
Eroded rolling phase.....	56	Pekin silt loam.....	81
Hilly phase.....	56	Rebuck silt loam.....	81
Rolling phase.....	57	Eroded phase.....	82
Klinesville gravelly silt loam:		Riverwash (coal screenings).....	82
Eroded hill phase.....	57	Rough stony land:	
Eroded phase.....	57	Dekalb soil material.....	82
Eroded undulating phase.....	58	Weikert soil material.....	83
Undulating phase.....	58	Rushtown shaly silt loam.....	83
Klinesville shaly silt loam:		Eroded rolling phase.....	84
Eroded hill phase.....	58	Ryder silt loam.....	84
Eroded phase.....	58	Schuylkill silt loam.....	85
Eroded steep phase.....	59	Sciotoville sandy loam.....	85
Eroded undulating phase.....	59	Sciotoville silt loam.....	85
Undulating phase.....	60	Sedan cherty silt loam.....	86
Klinesville stony loam.....	60	Eroded phase.....	87
Kreamer cherty silt loam:		Eroded rolling phase.....	87
Eroded hilly phase.....	60	Sedan gravelly silt loam,	
Eroded phase.....	61	eroded phase.....	87
Eroded rolling phase.....	61	Senecaville silt loam.....	88
Kutztown shaly silt loam:		Shelmadine silt loam.....	89
Eroded hill phase.....	62	Springtown stony loam.....	90
Eroded phase.....	62	Hill phase.....	90
Eroded sloping phase.....	63	Stephensburg shaly silt loam.....	91
Gently sloping phase.....	63	Eroded hilly phase.....	91
Lakin loamy fine sand.....	63	Eroded phase.....	92
Leck Kill channery silt loam.....	64	Eroded rolling phase.....	92
Eroded hilly phase.....	65	Tioga sandy loam.....	92
Eroded phase.....	65	Tioga silt loam.....	93
Eroded rolling phase.....	65	Trexler channery loam.....	94
Leetonia stony loamy coarse		Eroded phase.....	94
sand.....	66	Steep phase.....	94
Lickdale stony silt loam.....	66	Trexler channery silt loam.....	95
Lindside sandy loam.....	67	Eroded hilly phase.....	95
Lindside silt loam.....	67	Eroded phase.....	96
Lycoming stony loam.....	68	Eroded rolling phase.....	96
Made land.....	69	Rolling phase.....	96
Mazeppa silt loam.....	69	Trexler gravelly silt loam.....	97
Eroded rolling phase.....	69	Turbotville silt loam.....	97
Melvin sandy loam.....	70	Eroded gently rolling	
Melvin silt loam.....	70	phase.....	98
Mertz cherty silt loam.....	71	Eroded phase.....	98
Eroded hill phase.....	72	Warrior gravelly silt loam.....	99
Eroded phase.....	72	Eroded phase.....	99
Eroded rolling phase.....	73	Eroded sloping phase.....	100
Rolling phase.....	73	Washington gravelly silt	
Middlebury silt loam.....	73	loam.....	100
Mifflinburg silt loam.....	74	Eroded phase.....	100
Eroded phase.....	75	Washington silt loam.....	101
Eroded rolling phase.....	75	Eroded phase.....	102
Mine dumps.....	75	Eroded rolling phase.....	102
Montgomery silty clay		Watson gravelly silt loam.....	102
loam.....	76	Eroded phase.....	103
Natalie stony silt loam.....	76	Eroded sloping phase.....	103
Northumberland shaly silt		Strongly sloping phase.....	104
loam:		Watson stony loam.....	104
Eroded hill phase.....	77	Strongly sloping phase.....	104
Eroded phase.....	77	Weikert channery silt loam.....	105
Eroded rolling phase.....	78	Eroded hilly phase.....	105

Soils—Continued	Page	Soils—Continued	Page
Descriptions of the soils—Con.		Descriptions of the soils—Con.	
Weikert channery silt loam—		Williamsburg silt loam.....	112
Continued		Wiltshire silt loam.....	112
Eroded rolling phase.....	106	Use, management, and produc-	
Eroded steep phase.....	106	tivity of the soils.....	113
Hilly phase.....	107	General relationships.....	113
Rolling phase.....	107	Management practices and	
Steep phase.....	107	soil characteristics.....	113
Very steep phase.....	107	Crop rotations.....	114
Weikert flaggy loam.....	107	Fertilizers.....	115
Weikert shaly silt loam.....	108	Farm manure.....	116
Eroded rolling phase.....	108	Lime.....	116
Rolling phase.....	109	Soil management groups.....	116
Wheeling loam.....	109	Estimated yields.....	137
Wheeling sandy loam.....	110	Water control on the land.....	143
Eroded strongly sloping		Control of runoff and erosion..	143
phase.....	110	Drainage.....	144
Wheeling silt loam:		Forests.....	146
Eroded shallow phase.....	111	Morphology and genesis of soils..	148
Eroded strongly sloping			
shallow phase.....	111		

TABLES

1. Normal monthly, seasonal, and annual temperature and precipitation.....	7
2. Acreage of principal crops and number of bearing fruit trees and grapevines in Montour and Northumberland Counties.....	12
3. Key showing outstanding relations among soil series of Montour and Northumberland Counties.....	20
4. Acreage and proportionate extent of the soils mapped in Montour and Northumberland Counties.....	27
5. Management group 1.....	118
6. Management group 2.....	122
7. Management group 3.....	124
8. Management group 4.....	128
9. Management group 5.....	130
10. Management group 6.....	132
11. Management group 7.....	133
12. Management group 8.....	134
13. Management group 9.....	136
14. Average acre yields of the principal crops.....	138

MANY level to rolling valleys and narrow and broad ridges cross Montour and Northumberland Counties from northeast to southwest. The area was glaciated, and many of the soils have developed from underlying glacial till. The deep well-drained soils, the soils underlain by limestone, and the bottom land and terrace soils along the Susquehanna River and its tributaries are the best for agriculture. The southeastern part of the area, where the hard-coal mining industry is located, is occupied mainly by forested mountains. The agriculture of the two counties is very similar; it consists largely of general farming and dairying supplemented by poultry raising and vegetable growing. Corn, wheat, oats, and hay are the principal crops. Nearly half of the people of the two counties are employed in industries other than agriculture, principally metal, textile, food, and mining industries. The industrial population provides a ready market for farm products. To make possible the best agricultural uses of the land, this cooperative soil survey of the counties was made by the United States Department of Agriculture and the Pennsylvania State University College of Agriculture and Experiment Station. Field work was completed in 1942 and unless otherwise specifically mentioned, all statements in this report refer to conditions in the counties at that time.

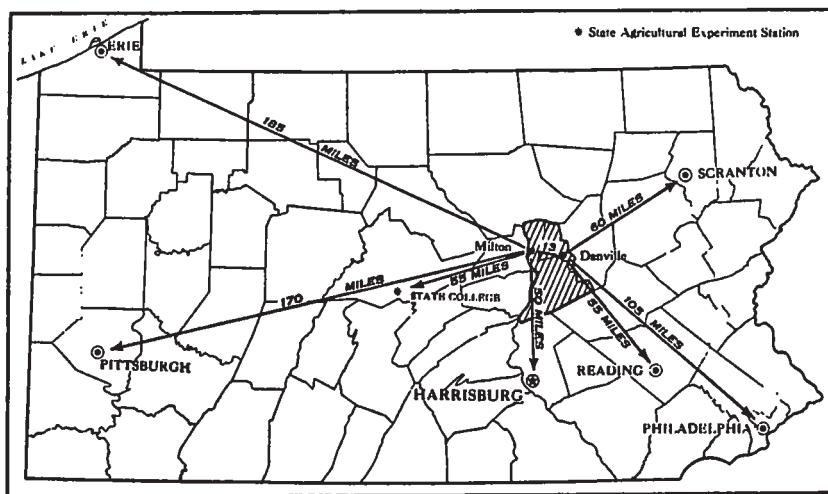


FIGURE 1.—Location of Montour and Northumberland Counties in Pennsylvania.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

MONTOUR AND NORTHUMBERLAND COUNTIES are in the east-central part of Pennsylvania (fig. 1). The total area of the two counties is about 587 square miles, or 375,955 acres. Milton, in Northumberland County on the West Branch of the Susquehanna River along the western boundary of the area, is 170 miles northeast of Pittsburgh and 50 miles north of Harrisburg.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

PHYSIOGRAPHY AND RELIEF

The two counties lie within the Ridge and Valley province of the Appalachian Highlands. The western and northern parts of the counties are included mainly in the Susquehanna lowland belt of this province.

The two counties consist of numerous level to rolling valleys, high hills, and narrow and broad mountain ridges. Folding and faulting of the rocks and differential weathering caused by variations in the underlying rocks have resulted in a series of valleys and ridges that run roughly parallel in a northeast-southwest direction. The northern part of the two counties is largely a broad valley, bounded on the extreme north by the Muncy Hills that extend southward into the area from $\frac{3}{4}$ to 2 miles. The central section from north to south, which includes the southern part of Montour County and the central part of Northumberland County, consists of a series of narrow rolling valleys, narrow mountain ranges, and rolling to hilly uplands. The southern part of Northumberland County, largely rolling and mountainous, is dissected by narrow valleys that widen as they approach the Susquehanna River. The southeastern part, which includes the hard-coal mining district, consists principally of mountains that range in elevation from 1,100 to 1,800 feet.

During the glacial ages, two ice sheets—the Jerseyan and the Illinoian—entered Montour and Northumberland Counties and had a part in the development of their present relief. These ice sheets smoothed off the ridges and partly filled some of the valleys, but the general pattern of the valleys and ridges remained intact. Just to the north of these counties, however, an ice sheet invaded during the last glacial period, the Wisconsin. The results of glaciation are therefore more evident to the north than they are in Montour and Northumberland Counties.

The following physiographic divisions, listed from north to south, occur in the counties: (1) the Muncy Hills; (2) the broad lowland belt; (3) Montour Ridge; (4) the Danville-Northumberland Valley; (5) the low hills underlain by shale; (6) Gilgers Ridge and its extension; (7) Irish Valley and its extension; (8) Brush Valley and its extension; (9) Big Mountain in the southeastern part of Northumberland County; and (10) undulating to hilly lowlands underlain by shale in the southwestern part of Northumberland County.

Muncy Hills.—These hills, at the northern end of the area, are underlain largely by thick shale formations of the Chemung group. The hills owe their elevated position to the fairly resistant character of the underlying shale formations.

Broad lowland belt.—Thin-bedded black shale, red shale, olive-gray shale, and limestone underlie the broad valley (about 500 to 800 feet above sea level) that extends from the Muncy Hills to Montour Ridge. The valley exists because these shales and limestone are consistently less resistant to weathering than those of Montour Ridge and the Muncy Hills. The rocks of the valleys, although their rates of weathering are not equal, all weather faster than those of the enclosing highland. The shales show wide variations in content of calcium and magnesium carbonates. The black shale, which is the most extensive, is slightly calcareous. The red shale and olive-gray shale between Milton, Washingtonville, and Dewart are calcareous, and the overlying soils are fairly well supplied with lime. Just north of Frosty Valley, extending 4 or 5 miles from the east into Montour County in the shape of a wedge, is a high rolling to hilly area similar to the Muncy Hills and underlain by fairly thick shale formations.

Montour Ridge.—This is a rounded mountain, 1,425 feet elevation at its highest point, composed of gray and brown shale and sandstone that offer high resistance to weathering.

Danville-Northumberland Valley.—This narrow level to undulating valley (average elevation about 600 feet) is underlain by narrow belts of Helderberg limestone, Bloomsburg red shale, black Marcellus shale, olive-gray Salina shale, and Shriver chert. The formations contain an abundant supply of calcium carbonate but are covered with material largely leached of its calcium and magnesium compounds.

Low hills underlain by shale.—South of the valley along U. S. Highway No. 11, at an average elevation of 800 feet, occur undulating, rolling, and hilly areas that are moderately good farming land. They are underlain largely by red acid shale. Some black thin-bedded Marcellus shale occurs along the valley of Shamokin Creek and extends beyond Elysburg, and also is found near Seven Points.

Gilgers Ridge and its extension.—Gilgers Ridge and the high hills south of Stonington consist of grayish-brown, acid, flaggy shales, largely of the Chemung group. Some of the knobs are about 1,250

feet above sea level. These high hills are stony and largely too steep for tillage.

Irish Valley and its extension.—South of Gilgers Ridge is Irish Valley, which averages about 1 mile in width and extends from the Susquehanna River east into Columbia County. It is largely undulating and rolling and is underlain by acid red shale that gives rise to moderately fertile soils.

Brush Valley and its extension.—This narrow valley and its extension to the southwest is underlain by acid red shale. The average elevation of the valley is 800 feet above sea level. About half of the red shaly material of this valley is covered with colluvium consisting of gray sandy material and rock from the surrounding steep mountain slopes.

Big Mountain.—This mountain in the southeastern part of Northumberland County has high rolling to steep slopes and ridges cut into by several shallow mountain valleys. The mountain is composed of sandstone with some quartzite and shale. The material is very hard and highly resistant to weathering. The highest point in the area, about 3 miles southeast of Shamokin, is 1,872 feet above sea level. Most of this mountain area is drained by Shamokin and Mahanoy Creeks.

Undulating to hilly lowlands underlain by shale.—This is a highly dissected undulating to rolling and hilly area largely underlain by acid red shale. Some strips or belts of Shriver Chert, Helderberg limestone, and acid gray shale also occur. Hooflander Mountain and Fisher Ridge are located almost in the center of this area. Both are small and narrow and attain a maximum height of about 1,100 feet. As a whole, this area is much like the one lying between the North Branch of the Susquehanna River and Gilgers Ridge. It is moderately fertile farming land except where the soil is shallow over the shale formations.

DRAINAGE

The general slope of the two counties, and hence the general direction of drainage, is from northeast to southwest, although minor tributaries of the rivers flow in southerly or northerly directions. The Susquehanna River and its tributaries drain the entire area. Important tributaries that drain a large part of the two counties are, in order from north to south, Warrior Run, Chillisquaque Creek, Shamokin Creek, Hollowing Run, Mahanoy Creek, Fidlers Run, and Mahantango Creek. The lowest point in the two counties is where the Susquehanna River leaves Northumberland County at its southwestern corner.

Remnants of old terraces occur from 100 to 250 feet above the present bed of the Susquehanna River. Other lower terraces flank the streams in many places. Assorted fine sands and silty material are characteristic of these old water-laid deposits.

CLIMATE

The continental, or inland, climate of Montour and Northumberland Counties is typical of that in east-central Pennsylvania. The summers are warm. The cold, moderately long winters have much foggy and cloudy weather. The prevailing winds are from the west.

Temperature and precipitation at Selinsgrove, across the Susquehanna River from Northumberland County, are considered representa-

tive for the farming sections of the two counties. Normal monthly, seasonal, and annual precipitation and temperature from the United States Weather Bureau Station at Selinsgrove are given in table 1.

In general, temperature and precipitation do not vary to any appreciable extent in the agricultural section of the two counties. The plateaus and ridges, however, are several degrees cooler than the valleys during most of the year. This is the result of higher elevation and greater air movement. The large forested areas in the mountains and the hard-coal regions are 400 to 500 feet higher than the farming sections and consequently temperatures are several degrees lower throughout the year.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Selinsgrove, Snyder County, Pa.*

[Elevation, 437 feet]

Month	Temperature ¹			Precipitation ²			
	Average	Absolute maximum	Absolute minimum	Average	Total for the driest year	Total for the wettest year	Average snowfall
	^{°F.}	^{°F.}	^{°F.}	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
December.....	31. 6	69	—10	3. 04	2. 74	3. 97	7. 3
January.....	28. 7	66	—27	3. 01	1. 46	8. 59	10. 5
February.....	28. 6	71	—22	2. 73	2. 91	3. 09	11. 4
Winter.....	29. 6	71	—27	8. 78	7. 11	15. 65	29. 2
March.....	38. 7	84	—11	3. 69	2. 71	8. 39	8. 7
April.....	49. 4	94	7	3. 55	2. 97	1. 82	2. 1
May.....	60. 8	96	26	4. 04	3. 40	1. 36	(³)
Spring.....	49. 6	96	—11	11. 28	9. 08	11. 57	10. 8
June.....	69. 1	99	30	3. 92	3. 50	4. 74	0
July.....	73. 4	105	40	4. 04	1. 08	6. 69	0
August.....	71. 4	105	40	3. 94	1. 11	7. 18	0
Summer.....	71. 3	105	30	11. 90	5. 69	18. 61	0
September.....	64. 8	97	29	3. 43	1. 08	4. 12	0
October.....	52. 9	90	18	3. 57	. 68	4. 46	. 1
November.....	41. 8	77	—1	2. 84	. 68	3. 85	1. 6
Fall.....	53. 1	97	—1	9. 84	2. 44	12. 43	1. 7
Year.....	50. 9	105	—27	41. 80	⁴ 24. 32	⁵ 58. 26	41. 7

¹ Average temperature based on 62-year record, 1890 to 1951; highest and lowest temperatures from 38-year record, 1893 to 1930.

² Average precipitation based on 62-year record, 1890 to 1951; wettest and driest years based on 42-year record, 1889 to 1930; snowfall on 40-year record, 1891 to 1930.

³ Trace.

⁴ In 1930.

⁵ In 1891.

The average annual temperature at Selinsgrove is 50.9° F. The difference between average summer and winter temperatures is 41.7°. The average frost-free season extends from May 4 to October 9, a period of 158 days. Killing frosts have been recorded, however, as early as September 11 and as late as June 10.

The warm summers and general absence of dry hot winds favor all crops grown in this section, although oats generally yield better in a slightly cooler climate. The winters, though seldom severe, are cold enough to prevent frequent freezing and thawing. Nevertheless, alfalfa, red clover, wheat, and similar crops on imperfectly or poorly drained land are considerably damaged by heaving of the roots during spells of freezing and thawing.

The average annual precipitation of 41.8 inches is ample. More than a fourth of it comes in June, July, and August, the time it is needed for most crops. Short dry spells in July are preferred times for harvesting wheat and oats. Torrential downpours are not frequent, although some soil-washing rains can be expected during the summer months.

The average snowfall at Selinsgrove is 41.7 inches. The snow usually disappears near the end of February or early in March, although heavy snowfalls have occurred in April. Spring growth of vegetation is rather slow and advances unevenly in different years. Occasionally the season is too short for satisfactory maturing of corn on naturally wet soils that warm up slowly in spring. Fruit blossoms are severely damaged by frosts every 2 or 3 years. The hazard of frost is naturally greater in the valleys than on the slopes and ridges, where air drainage is better and moisture is less likely to accumulate.

WATER SUPPLY

In Montour and Northumberland Counties the red shale belts of the Bloomsburg and Mauch Chunk formations yield softer water than the other formations in the lowlands. Wells in the limestones and calcareous shales that underlie much of the northern part of the area, north of Montour Ridge, yield water that is generally hard but satisfactory for most uses.

Hand-dug wells supply some of the farms in the valleys, but the newer wells have been drilled. Shamokin obtains its water from storage lakes, Sunbury from storage basins of water piped from Plum Creek, and Danville from the North Branch of the Susquehanna River.

The rivers and streams of the two counties offer facilities for fishing, duck hunting, and swimming. Some campsites, swimming pools, and cabins have been erected and are available for rent to the public.

VEGETATION

Before settlement by white men most of this area was covered with virgin forests consisting of oak, chestnut, and pine and hemlock mixed with hickory, red maple, locust, and a few conifers. Such trees as white oak, black walnut, and locust were considered indicators of good soil and were common in the valleys, especially on soils high in lime. Chestnut, chestnut oak, and mountain-laurel were more common in the mountains.

During Indian occupation some of the valleys were not entirely covered by forests. Many of the lower valleys and sharp ridges were

occupied by a mixture of wild grasses, sedges, briars, and a scattered tree growth consisting of mixed hardwood, maple, chestnut, elm, and conifers.

The present forest consists of about 95 percent broadleaved trees and about 5 percent conifers. The dominant broadleaved species are chestnut oak, maple, and red oak. Other common deciduous trees are scarlet oak, white oak, birch, elm, aspen, and hickory. On the deeper soils at the base of the mountain slopes, white oak, maple, elm, birch, and yellow-poplar are more prevalent. Mountain-laurel and huckleberries compose most of the undergrowth. On the soils of the flood plains, sycamore, hard maple, white oak, red oak, yellow-poplar, willow, birch, ash, and hemlock are common. Additional information on forest trees will be found in the section on forests.

The predominant species of grasses in pastures are Kentucky bluegrass, white clover, orchard grass, Canada bluegrass, and timothy. In addition, weeds form a large part of some meadows, especially abandoned fields. These weeds are principally ragweed, wild carrot, yellow mustard, and poverty oatgrass. Goldenrod, devils-paintbrush, and milkweed are also plentiful in a few idle fields. Where lime is used liberally, Kentucky bluegrass and white clover are plentiful and crowd out many of the coarser grasses and weeds.

Old fields that have been abandoned 5 to 10 years are occupied by sassafras, persimmon, and different species of pine in addition to an undercover of weeds and coarse grasses. In the absence of fire or logging, hardwoods and maple commonly replace the pine under natural conditions.

EARLY HISTORY AND POPULATION

The aboriginal inhabitants of Northumberland and Montour Counties were the Muncy Indians of the Delaware tribes. They lived mostly along the Susquehanna River and larger tributary streams.

The first white settlements in what is now Northumberland County were made prior to 1750 along the Susquehanna River. At that time this area was in Cumberland County and included the territory purchased in 1754 under the Albany Treaty. The Indians, claiming they had been deceived by the purchase, were embittered and killed or captured all the men, women, and children in these settlements. It was about 1768 before white people settled in the area again.

Northumberland County was formed in 1772 from parts of Lancaster, Cumberland, Berks, Bedford, and Northampton Counties. Montour County was formed from Columbia County in 1850.

The early settlers were English, Scotch, Irish, and Pennsylvania Dutch (Germans) who came from counties to the south and east. The present population consists largely of descendants of English and a mixture of English, Scotch, and Irish in Montour County and the northern and central parts of Northumberland Counties. In the agricultural section south of Big Mountain the people are largely of Pennsylvania Dutch (German) descent. Most of the inhabitants of the coal mining localities are of Polish, Lithuanian, and Italian extraction.

The population is well distributed over the agricultural sections of the county, although it is slightly denser in the valleys than in the higher rolling to hilly areas. Montour Ridge and Little Mountain

are very sparsely settled, since they are largely wooded and lumbering is the principal industry. In the coal-mining area in the southeastern part of Northumberland County practically all of the population is concentrated in towns, mainly in Shamokin, Kulpmont, and Mount Carmel. The United States Census of 1950 reported a population of 16,879 for Shamokin, the largest town in the area. The other towns in order of population are Sunbury, the county seat, 15,570; Mount Carmel, 14,222; Milton, 8,578; Kulpmont, 5,199; and Northumberland, 4,207. Danville, the county seat of Montour County, had a population of 6,994 in 1950. Numerous smaller towns and villages are located in the valleys of the two counties. The towns serve as markets and shipping points for the agricultural products.

The total population of Northumberland County in 1950 was 117,115, of which 82,429 were classed as urban and 34,686 as rural. Montour County had a population of 16,001 in 1950, of which 6,994 were classed as urban and 9,007 as rural.

TRANSPORTATION FACILITIES, SCHOOLS, CHURCHES, AND HOSPITALS

Branch lines of the Pennsylvania Railroad and Reading Railway System cross both counties from north to south and from east to west. They pass through all of the larger towns and many of the smaller villages. The Pennsylvania Railroad has lines along the Susquehanna River and its North and West Branches; and the Delaware, Lackawanna and Western Railroad runs from Northumberland up the North Branch of the Susquehanna River.

Both Northumberland and Montour Counties have a well-developed network of hard-surfaced roads that reach within 3 miles of every point in the area. In addition to macadam and concrete highways, a system of graded dirt and shale roads extends throughout the farming district. Most of the farm products are hauled by trucks to cities, local towns, and villages. Coal is hauled by truck rather than railroad to consumers within the two counties.

A large number of the schools are consolidated. One- and two-teacher schools are also numerous. High schools are located in Sunbury, Milton, Turbotville, Watsontown, Shamokin, Kulpmont, Mount Carmel, Herndon, Dalmatia, and Trevorton in Northumberland County and in Danville and Washingtonville in Montour County. Washingtonville has also a junior high school. Churches are located throughout the rural districts as well as in all the towns. There is a large State hospital and sanatorium on the outskirts of Danville.

INDUSTRIAL DEVELOPMENT

At the time of survey (1942) nearly half of the people in Montour and Northumberland Counties were employed in industries other than agriculture. Metal, textile, and food industries employ a large number of people in Sunbury, Milton, Northumberland, and Danville. In addition gristmills and flour mills are located at convenient places in the agricultural sections. Several large limestone quarries supplemented by numerous small farm quarries furnished ground limestone for farms and crushed stone for roads. A large brick kiln is located near Milton, as well as a large vegetable cannery that is a market for most of the tomatoes and sweet corn grown in the two counties. These

industries furnish work for many people, who in turn buy local farm products.

Hard-coal mining, which extends into the southeastern part of Northumberland County, supports the people of that section.

AGRICULTURE

The Indians depended more on agriculture for a living than has commonly been supposed and supplemented it by hunting and fishing. They raised no livestock, however, and knew nothing of scientific farming. Their principal crop was maize, though they grew quantities of beans, peas, squashes, pumpkins, melons, tobacco, peppers, and sweetpotatoes. They gathered the wild berries, fruits, roots, and nuts with which the forests then abounded.

The first permanent white settlers used crude methods of farming. In many ways, especially in clearing of land and tillage of corn, their methods resembled those of the Indians. Wheat and corn were the leading crops, and oats, barley, and rye the minor ones. Rye was used almost entirely for distillation of whisky. Tobacco was grown only in small patches for home use. Potatoes and English grasses were soon introduced, but timothy and red clover were not grown until the early part of the 19th century.

Early industries were established to meet local needs. Since food and shelter were the primary considerations, gristmills and sawmills supplied the first manufactured products. Hemp, flax, and wool were produced by the early settlers for the manufacture of textiles.

At first the settlers relied on rivers and Indian trails, but a system of imperfect roads was gradually constructed into the interior of the counties. Traffic was carried by rafts and flatboats on the Susquehanna River and its North Branch. Baltimore was the best and most accessible market for surplus products. Pack horses were used considerably for overland transportation. The eventual building of canals and turnpikes or toll roads helped to solve the transportation problems. A canal was in operation up the Susquehanna River as early as 1830, and was much used until railroads were built.

CROPS

The present agriculture is based principally on dairying and general farming and includes the production of cereals and hay crops, vegetables, fruits, livestock, and livestock products. Corn, wheat, and oats are the important cereal crops, and their acreages do not differ greatly. Several minor crops, soybeans, and alfalfa have been increasing in acreage in both counties.

Acreages of the principal crops and number of bearing fruit trees and grapevines in Montour and Northumberland Counties are given in table 2.

The decrease in acreage of some crops since 1929 is not necessarily detrimental, as a large part of the land taken out of cultivation has been reforested. Reforestation has not been practiced enough on many of the hilly and steep areas. At the time of survey many fields were lying idle and producing no income. Some of the abandoned fields, however, had been sown to permanent pasture, which is urgently needed for grazing, since milk production has become one of the main sources of farm income.

TABLE 2.—Acreage of principal crops and number of bearing fruit trees and grapevines in Montour and Northumberland Counties, Pa., in stated years

Crop	Montour County			Northumberland County		
	1929	1939	1949	1929	1939	1949
Corn:	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
For all purposes.....	8,762	9,154	10,129	22,985	21,381	23,277
Harvested for grain.....	7,975	8,369	8,956	20,695	19,618	20,609
Small grains threshed:						
Wheat.....	9,049	8,064	9,196	24,087	19,266	20,142
Oats.....	7,896	7,358	7,179	20,157	16,897	16,030
Rye.....	1,368	1,086	272	2,919	1,234	304
Barley.....	20	266	231	186	512	791
Buckwheat.....	760	682	866	1,489	533	793
Soybeans grown alone.....	27	899	1,341	127	1,106	1,225
All hay.....	10,347	9,741	9,877	26,474	22,170	21,166
Alfalfa.....	44	348	424	317	1,031	1,336
Clover and timothy.....	10,150	9,285	9,291	25,335	19,303	19,460
Grains cut green.....	3	74	35	29	443	88
Other hay.....	150	434	127	793	1,393	282
White potatoes for sale and home use.....	644	522	136	3,380	2,461	1,211
All other vegetables and melons for sale.....	98	512	521	1,018	1,582	1,469
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Apple.....trees.....	13,752	16,027	7,924	82,272	38,847	27,889
Peach.....do.....	5,731	4,329	2,944	31,855	21,092	19,459
Pear.....do.....	1,780	1,774	894	9,039	4,712	1,870
Cherry.....do.....	2,536	2,535	928	9,452	3,904	1,940
Plum and prune.....do.....	1,172	724	93	5,235	1,349	638
Grapevines.....	7,157	12,694	3,399	24,739	22,288	3,554

¹ Includes annual legumes cut for hay, clovers grown alone, other tame grasses, and wild hay.

² Does not include acres for farms with less than 15 bushels harvested.

At one time rye was a fairly important crop in the area, but it is now grown only in patches, mainly as a winter cover crop. Soybeans have become a major crop in recent years. Potatoes are the most widely grown of the special crops, followed by sweet corn and tomatoes.

Vegetable crops harvested for sale are not listed separately in table 2. The most important vegetables, in order of their total acreage in both counties in 1950, are tomatoes, sweet corn, green peas, cabbage, and beans.

Apples are the most valuable fruit crop; peaches, pears, cherries, and grapes are next in order. On many farms the fruit trees are neglected, but in commercial orchards they are well-kept and are sprayed and trimmed regularly.

The pasture grasses are mainly Kentucky bluegrass, timothy, red clover, and white clover—the bluegrass predominating. On hilly areas and steep slopes orchard grass and alfalfa are sown with these grasses. Canada bluegrass thrives better than red clover or Kentucky

bluegrass on the poorly drained soils. Weeds are numerous in many of the pastures.

All crops except wheat and timothy are planted in spring. Farmers are now sowing more alfalfa in spring than in fall to allow the roots to penetrate deeper into the soil before freezing and thawing sets in.

LIVESTOCK AND LIVESTOCK PRODUCTS

The 1950 census reports 5,988 cattle and calves in Montour County and 15,159 in Northumberland. Cows milked totaled 3,215 in Montour County and 7,240 in Northumberland.

The number of horses and mules has steadily declined as more automobiles and tractors have come into use. Hogs and pigs totaled 15,752 in the two counties in 1950. Sheep and lambs reported for the two counties totaled 1,192 in 1950. There were 512,128 chickens on farms of the two counties in 1950.

Dairying is the most important branch of livestock farming and is highly specialized in comparison with 30 years ago. The dairies concentrate mainly on production of whole milk for sale. Most of the milk is sold in local towns and the hard-coal region.

Most of the dairy cows are mixed grades. Holstein-Friesians predominate, and next in order of popularity are Guernseys, Jerseys, and Ayrshires. Hereford and Aberdeen Angus are favored beef breeds in the two counties. The number of beef cattle is considerably less than that of dairy breeds. The principal breeds of hogs are Poland China, Chester White, and Duroc.

With the change from beef cattle to dairy cattle, the purchase of concentrated feed has increased. In 1950 slightly more than 80 percent of the farms of Northumberland County reported purchase of livestock and poultry feed, and in Montour County 81 percent of the farms reported expenditure for this purpose. Expenditures for concentrated mixed dairy feeds and cottonseed meal are highest, and those for chicken feed are next.

LAND USE

In Northumberland County 59.3 percent of the total land was in farms in 1949. The average size of the farms was 91.5 acres. In Montour County land in farms was 85.3 percent of all land, and the average size farm was 110.4 acres. The percentage of land in farms in both Northumberland and Montour Counties has decreased considerably since 1920. Numerous areas of steep and submarginal land have reverted to forest.

In 1949 land in farms and use of land in farms were as follows:

	Montour (Acres)	Northumberland (Acres)
Land in farms.....	71, 010	172, 311
Cropland harvested.....	40, 343	88, 092
Cropland used only for pasture ¹	3, 118	10, 700
Cropland not harvested and not pastured....	6, 222	19, 583
Woodland pastured.....	1, 263	1, 695
Woodland not pastured.....	11, 173	30, 934
Other pasture (not cropland and not woodland).....	3, 502	7, 922
Other land (house lots, roads, wasteland, etc.)	5, 389	13, 385

¹ Includes rotation pasture.

FARM TENURE

According to the 1950 United States census, 84.1 percent of the farms in Montour County were operated by full and part owners, 15.1 percent by tenants, and 0.8 percent by managers. In Northumberland County the distribution was 89.2 percent of the farms operated by full and part owners, 10.5 percent by tenants, and 0.3 percent by managers. The proportion of tenancy has decreased since 1930.

Most tenants rent on a 50-50 basis. The owner and tenant each furnish half the seed, fertilizer, and lime. The tenant supplies machinery, livestock, and labor and gets all returns from the livestock and half the returns from grain crops. The owner ordinarily pays the taxes. Individuals often agree on other systems of tenancy.

FARM POWER AND EQUIPMENT

In the 1950 census farm power was reported as follows:

	Montour	Northumberland
Total number of farms.....	643	1,883
No tractor or horses or mules.....	106	459
No tractor and only 1 horse or mule.....	10	19
No tractor and 2 or more horses or mules.....	20	190
Tractor and horses or mules.....	148	331
Tractor and no horses or mules.....	359	884

Most farms in this area have modern farm equipment such as grain binders, riding cultivators, seed drills, corn planters, plows and harrows, manure spreaders, rakes, mowers, and smaller implements. In addition some farmers own combines. Motortrucks were reported on 277 farms in Montour County in 1950, and on 998 farms in Northumberland County. The large potato growers and commercial fruit growers in the area own spraying equipment.

Farm equipment varies according to the productivity and workability of the land. Trucks, tractors, and combines are common on the more productive soils but scarce in the rougher and poorer parts of the area. Tractor farming is steadily increasing in both counties.

Farm buildings, farm improvements, and modern conveniences in the rural home reflect, in general, the soil character and land conditions. Buildings are large and substantial on the deep well-drained soils in areas underlain by calcareous shale and limestone, and on farms that include large parts of the bottom and terrace land along the two rivers and some of their larger tributaries (pl. 1, A).

TYPES AND SIZES OF FARMS

The 1950 census classifies the farms of the two counties as follows:

Type of farm:	Montour (Number)	Northumberland (Number)
Field crop:		
Cash-grain.....	61	123
Other field crops.....	0	31
Vegetable.....	5	21
Fruit and nut.....	5	10
Dairy.....	212	327
Poultry.....	52	442
Livestock.....	9	56
General:		
Primarily crop.....	9	15
Primarily livestock.....	28	102
Crop and livestock.....	70	149
Miscellaneous and unclassified.....	192	607

By size, the farms of the two counties were classified in the 1950 census as follows:

Size range:	Montgomery (Number)	Northumberland (Number)
Under 10 acres.....	36	193
10 to 29 acres.....	42	202
30 to 49 acres.....	55	195
50 to 69 acres.....	66	213
70 to 99 acres.....	113	348
100 to 139 acres.....	150	381
140 to 179 acres.....	84	178
180 to 219 acres.....	36	81
220 to 259 acres.....	34	24
260 to 499 acres.....	25	59
500 to 999 acres.....	2	9

Most of the small farms are close to the larger towns. The dairy and the field crop farms are scattered throughout the counties, although the proportion of dairy farms is slightly greater in the valleys and near larger towns. The field crop and general farms are fairly uniform in distribution, though most of the corn, hay, and pasture is grown in the hilly areas. The unclassified farms, which include those producing mainly for home use, tend to be in the more isolated sections.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field. The soil scientist walks over the area at intervals not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each such boring or hole shows the soil to consist of several distinctly different layers, called horizons, which are collectively known as the soil profile. Each of these layers is studied carefully for characteristics that affect the use of the soil.

The color of each layer is noted. The darkness of the topmost layer is usually related to its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration.

Texture, or the content of sand, silt, and clay in each layer, is determined by the way samples feel when rubbed between the fingers and is checked by mechanical analyses in the laboratory. Texture has much to do with the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizers will be held by the soil in forms available to plants or will be leached out, and how difficult the soil may be to cultivate. Structure, or the way the soil granulates, and the amount of pore or open space between particles indicate how easily plant roots can penetrate the soil and how easily water enters in.

Consistence, or the tendency of the soil to crumble, or to stick together, indicates how difficult it will be to keep the soil open and porous under cultivation.

The kinds of rocks and the resulting parent material from which the soil has developed affect the quantity and kind of plant nutrients the soil may have naturally. Simple chemical tests show how acid the soil may be. The degree of acidity indicates the need for lime. Soils with a pH of less than 6.5 usually respond to lime; those above pH 6.5 normally do not respond. Reaction is the degree of acidity or alkalinity.

ity of the soil. It may be expressed mathematically as the pH value.^a

The depth to bedrock or to compact layers is determined. The quantity of gravel or rocks that may interfere with cultivation, the steepness and kind of slope, the quantity of soil lost by erosion, and other external features are described.

On the basis of all these characteristics, soil areas much alike in the kind, thickness, and arrangement of layers are mapped as one soil type. A phase is a subdivision of the type. Some soil types possess a narrow range of characteristics and therefore are not divided into phases; others having a wide range of characteristics are mapped in two or more phases. For example, if a soil type has slopes that range from 3 to 25 percent, the type may be mapped in three slope phases—a gently sloping phase (3 to 7 percent slopes), a sloping phase (7 to 12 percent slopes), and a strongly sloping phase (12 to 25 percent slopes). As further example, a soil that has been eroded in places may be mapped in two or more phases—an uneroded phase, an eroded phase, and perhaps a severely eroded phase. A soil type will be broken into phases primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, content of stones, or extent of erosion are examples of characteristics that might cause a soil type to be divided into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture, especially of the surface layer, will differ. As long as the other characteristics of the soil layers are similar, these soils are considered to belong in the same soil series. A soil series, therefore, consists of all the soil types that have about the same kind, thickness, and arrangement of layers, except for texture, particularly of the surface layer, whether the number of such soil types be only one or several.

The name of a place where a soil series was first found is chosen as the name of the series; thus, Turbotville, Sedan, Dewart, and Watson are names of important series in these counties. The name of the surface texture is added to the series name to give the type name. Watson gravelly silt loam and Watson stony loam are names of two types within the Watson series. They differ in texture of the surface soils, as their names show.

Watson gravelly silt loam is divided into four phases because some of this type is gently sloping, some is sloping, and some is strongly sloping. All of the sloping phase is eroded, and some of the gently sloping phase. These phases are: Watson gravelly silt loam (the normal^a or uneroded gently sloping phase); Watson gravelly silt loam, eroded phase; Watson gravelly silt loam, eroded sloping phase; and Watson gravelly silt loam, strongly sloping phase. The gently sloping phases have slopes that fall from 3 to 7 feet in 100 feet of

pH		pH	
* Extremely acid.....	below 4.5	Neutral.....	6.6-7.3
Very strongly acid.....	4.5-5.0	Mildly alkaline.....	7.4-8.0
Strongly acid.....	5.1-5.5	Strongly alkaline.....	8.1-9.0
Medium acid.....	5.6-6.0	Very strongly alkaline	
Slightly acid.....	6.1-6.5		9.1 and higher

^a When a soil type consists of more than one phase, one of them is generally more common in occurrence than the others. In this report such a phase is considered to be the normal phase of the type and bears no phase designation in its name.

distance; the sloping phase has slopes that fall from 7 to 12 feet in 100; and the strongly sloping phase has slopes that fall from 12 feet to 25 feet in 100.

Areas such as rough stony hillsides and mine dumps that have little true soil are not designated with series and type names. Instead they are given descriptive names such as Rough stony land, Mine dumps, and so on.

The soil type or, where the type is subdivided, the soil phase, is the unit of mapping in soil surveys. Because they are more nearly uniform than broader groups or classes of soils, more definite statements about their use and management can be made. One can say, for example, that the soils of the Watson series are imperfectly drained, have a compact layer in the lower subsoil, have developed on Jerseyan till, are very strongly to extremely acid in reaction, and are responsive to good management practices in the production of the field crops common to the region. More specific statements can be made for the soil type or phase. It can be stated that Watson gravelly silt loam has mild slopes (3 to 7 percent) and is easier to work and less erodible than Watson gravelly silt loam, strongly sloping phase. It can also be stated that Watson gravelly silt loam has been less injured by erosion than Watson gravelly silt loam, eroded phase, and therefore is more productive. All of these phases are included in the Watson series.

SOILS

SOILS IN RELATION TO GEOLOGY

Understanding the soils of Montour and Northumberland Counties is easier if one has some knowledge of the kinds of rock that underlie the area and of the geologic processes that have gone on in the past. It is the work of these processes on the underlying rocks that has produced the parent materials from which the soils have formed.

Montour and Northumberland Counties are underlain by belts of different kinds of rock, such as sandstone, shale, and limestone, that run in a general southwesterly direction across the counties. These belts of rock have been weathered and eroded for millions of years. The sandstones and other harder rocks have formed the hills and mountains; the softer rocks, such as the shales or limestones, have been worn down to form the lowlands or low hills.

Many thousands of years ago, all of the area except the tops of the higher mountains was covered by a huge ice sheet, or glacier, that came from the north. This ice sheet is called the Jerseyan; apparently it was the oldest one in this part of the United States. Thousands of years later, another ice sheet, the Illinoian, entered the area as tongues of ice. Many of these tongues terminated in the valleys of Montour and Northumberland Counties. Much of the hilly and mountainous part was not covered by the Illinoian ice.

The deposits left by these ancient glaciers include glacial till, which is unsorted debris dropped by the ice, and sand and gravel laid down by streams as the ice melted. The deposits are very unevenly distributed in both counties, partly because of the steep slopes and partly because many of the deposits have been eroded away since the glacial periods.

In many areas formerly covered by the ice sheets, the bedrock is only a foot or two below the surface. In these areas the parent materials of the soils were derived entirely or in large part from the underlying bedrock, not from material brought in by the ice. In some valleys and on some of the broad rolling uplands, however, the old glacial tills are still present and range from 10 to 20 feet or more in depth.

Over most of the two counties materials from local geological formations have contributed more to soil characteristics than those from distant sources. The chemical and physical properties of these local materials, modified by weathering, were passed on to the soils. For example, soils in the red shale belts have been strongly influenced by the parent shale from which they are largely derived. Such soils are reddish brown, silty, and high in iron or other minerals.

The soils of Montour and Northumberland Counties are similar to those of nearby Union, Snyder, and Columbia Counties. The geological formations, or belts of various strata, such as Clinton shale, Chemung shale and sandstone, Salina shale, Bloomsburg red shale, and Marcellus shale, extend almost across the entire width of these counties in many places. The soils developed on the glacial material derived from these rocks owe many characteristics to them.

The soils of this area differ widely in color, texture, consistence, depth, reaction, fertility, and relief, as well as in conditions of stoniness, erosion, and moisture. Although they range in texture and consistence from loose incoherent loamy coarse sand to sticky clay, silt loams predominate in the surface layers. Channery^a and gravelly silt loams are next in extent. Friable silty clay loams predominate in the subsoils. A large part of the two counties, however, is covered by shallow soils that are a mass of shale or sandstone fragments mixed with a small quantity of soil material. These shallow soils have practically no developed subsoil. In general the soils developed on residual material can be distinguished from those developed on glacial till by their blocky or nuciform (nutlike) structure in the lower subsoil. The same horizon in the soils developed on glacial till is rather coarsely platy (flake-like).

The soils of Montour and Northumberland counties are very similar. Much of the two counties is unsuited to cultivated crops, mainly because of strong relief and stoniness. Nearly one-third of the soils in the valleys are limited in their suitability for crops because of imperfect or poor drainage. Northumberland county has a large tract of nonagricultural land in the southeastern part. Montour county has many soils underlain by black shale, and many of these soils are shallow and imperfectly to poorly drained.

SOIL SERIES AND THEIR RELATIONS

Presented in table 3 is a key showing some of the more outstanding relations among the soil series in Northumberland and Montour counties. The soil series listed in a horizontal line have developed from similar parent material but have profile differences caused largely by differences in natural drainage during their development. The series in one horizontal line form a soil catena, or group of soils developed on the same kind of parent material but having different relief and

^a A channery soil contains thin, flat sandstone, limestone or schist measuring up to 6 inches along the longer axis.

drainage and, consequently, differences in characteristics. The soil series listed in any one vertical column have similar natural drainage conditions but have differences in profile characteristics resulting from differences in their various parent materials.

The soils of Northumberland and Montour counties are placed in four main divisions in order that their relations may be more easily discussed: (1) Soils of uplands, (2) soils of terraces, (3) soils of bottom lands, and (4) miscellaneous land types.

SOILS OF UPLANDS

The soils of the uplands, grouped according to moisture and drainage conditions, are: (1) Well to excessively drained very shallow soils, (2) well to excessively drained shallow soils, (3) well-drained deep soils, (4) imperfectly drained soils, and (5) poorly drained soils.

WELL TO EXCESSIVELY DRAINED VERY SHALLOW SOILS

The well to excessively drained very shallow soils are members of the Hagerstown, Kistler, Klinesville, Kutztown, Northumberland, and Weikert series. All have developed from shallow pre-Wisconsin till and residual materials. These soils, together with the well to excessively drained shallow soils, dominate the more rolling, hilly, and steep areas of the two counties.

These very shallow soils are rather consistently less than 20 inches deep to bedrock, and in many places average less than 12 inches. They are droughty and are not so productive as the deeper soils. All are used for crops, but the Hagerstown, Kutztown, and Northumberland soils, derived from calcareous materials, are somewhat more productive, especially of legumes, than the other soils in the group.

WELL TO EXCESSIVELY DRAINED SHALLOW SOILS

The well to excessively drained shallow soils of the uplands are the Crestmore, Hartleton, Leck Kill (pl. 1, *B*), Leetonia, and Stephensburg, the Trexler channery loam soils (the other Trexler soils are deep), and the shallow phases of the Fleetwood soil. These soils have developed from residual material and pre-Wisconsin till. They range from about 18 to 36 inches in depth to bedrock but in most places are from about 20 to 30 inches. These soils are somewhat droughty—intermediate between the group of very shallow soils heretofore discussed and the group of well-drained deep soils that is next described.

WELL-DRAINED DEEP SOILS

The well-drained deep soils of the uplands have developed from Jerseyan glacial till, Illinoian glacial till, colluvial material, or residual material, or from a combination of Jerseyan till and residual material.

The Washington, Mifflinburg, and Ryder series—developed, respectively, from materials derived from limestone, calcareous shale, or shale and limestone—are the most productive soils of the uplands. They occur mainly in the northern part of the two counties in a rather small, triangular-shaped area enclosed within a boundary extending from 1 mile south of Milton to Washingtonville, to Dewart, and back to Milton.

TABLE 3.—*Key showing outstanding relations among soil series of Montour and Northumberland Counties, Pa.*¹

SOILS OF UPLANDS

Parent material	Well to excessively drained soils		Imperfectly drained soils	Poorly drained soils
	Shallow (less than 30 inches to bedrock)	Deep (more than 30 inches to bedrock)		
Weathered yellowish-brown slightly acid to weakly alkaline residuum and pre-Wisconsin till derived principally from gray Helderberg limestone.	Crestmore.....	Washington.....	Turbotville.....	
Strong-brown slightly acid to neutral residuum derived from gray Helderberg limestone.	Hagerstown.....			
Weathered light-yellow or yellowish-red strongly acid pre-Wisconsin till derived principally from cherty limestone (Shriver chert).		Mertz.....	Kreamer.....	
Residual pale-yellow very strongly acid material derived from cherty limestone (Shriver chert).		Elliber.....		
Weathered pale-olive neutral to slightly alkaline pre-Wisconsin till and residuum derived from interbedded gray shale and limestone.		Ryder.....		
Weathered neutral to mildly alkaline residuum and pre-Wisconsin till derived from olive-gray calcareous shale (Salina shale).	Kutztown.....	Mifflinburg.....		
Weathered weak reddish-brown slightly alkaline residuum and pre-Wisconsin till derived from calcareous red shale (Bloomsburg red shale).	Northumberland.....	Mazeppa.....		
		Sedan.....		

Weathered brown to reddish-brown moderately acid pre-Wisconsin till derived from gray cherty limestone, sandstone, and quartzite.				
Neutral to slightly alkaline colluvial materials from limestone or calcareous shales.			Wiltshire	
Weathered light yellowish-brown or brown residuum and pre-Wisconsin till derived principally from dark-gray or black Marcellus shale.	Kistler	}	Comly	
	Stephensburg			
Weathered moderate-brown to pale reddish-brown strongly acid pre-Wisconsin till and residuum derived from red, gray, and yellow shales (Catskill formation).	Leck Kill		Rebuck	
Weathered weak reddish-brown very strongly acid pre-Wisconsin till and residuum derived from acid red shale (Mauch Chunk or Bloomsburg red shale).	Klinesville		Norton	
Weathered yellowish-brown very strongly acid pre-Wisconsin till and residuum over gray and yellow unweathered shale bed-rock.	Weikert			
Weathered yellowish-brown or yellowish-red very strongly acid pre-Wisconsin till and residuum derived principally from acid gray sandstone, shale, and quartzite.	Hartleton		Allenwood	{ Watson (compact lower subsoil). Alvira
Weathered moderate-brown to yellowish-red very strongly acid pre-Wisconsin till derived principally from acid gray sandstone, shale, and quartzite.			Dewart	{ Warrior (compact lower subsoil) Alvira
Weathered weak reddish-brown very strongly acid pre-Wisconsin till derived from acid red shale, gray sandstone, and quartzite.			Springtown	
Weathered yellowish-brown very strongly acid pre-Wisconsin till and residuum over yellowish unweathered sandstone bed-rock.	Trexler (channery loams).		Trexler	

See footnote at end of table.

TABLE 3.—*Key showing outstanding relations among soil series of Montour and Northumberland Counties, Pa.—Con.*

Parent material	Well to excessively drained soils		Imperfectly drained soils	Poorly drained soils
	Shallow (less than 30 inches to bedrock)	Deep (more than 30 inches to bedrock)		
Residual light yellowish-brown extremely acid materials derived principally from acid gray sandstone and quartzite.	Leetonia.....	.....	.....	Lickdale.
Weathered light yellowish-brown very to extremely acid pre-Wisconsin till and residuum derived principally from acid gray quartzite.	Fleetwood (shallow phase).	Fleetwood.....	Natalie.....	Lickdale.
Colluvial materials principally of sandstone origin.	.....	Lycoming.....	Buchanan.....	Lickdale.
SOILS OF TERRACES				
Very strongly acid, bedded yellowish-brown alluvium or colluvium from acid shale.	.....	Rushtown.....	.....	.....
Very strongly acid yellowish-brown material derived principally from glaciated sandstone and shale areas; gravelly layers within 36 inches of the surface; some limestone derivation.	.....	Chenango.....	.....	.....
Strongly acid yellowish-brown material derived from glaciated sandstone and shale areas; gravelly layers below 36 inches from the surface.	Wheeling (shallow phases).	Wheeling.....	Sciotoville.....	{ Ginat (gray surfaced). Chilo (dark surfaced).
Wind-blown acid materials derived principally from the materials of the Wheeling soils.		Lakin.....	.....	.....

Moderately acid yellowish-brown, limestone-influenced, medium-textured materials derived principally from sandstone and shale areas thought to be of Illinoian age.	-----	Elkinsville-----	Pekin-----	Bartle.
Calcareous yellowish-brown stream deposits derived principally from glaciated limestone and calcareous shale areas.	-----	-----	Williamsburg-----	Montgomery.
Strongly acid light-gray silt and clay deposited in glacial lakes.	-----	-----	-----	Dubois.
Strongly acid light-gray silt and clay deposited in glacial lakes that has received a subsequent deposit of slightly acid to neutral material from the surrounding uplands.	-----	-----	Chillisquaque-----	-----

SOILS OF BOTTOM LANDS

Medium acid to neutral materials washed from sandstone, shale, and limestone areas.	-----	{ Ashton (infrequently overflowed) Huntington (frequently overflowed). Tioga-----	{ Lindsides----- Middlebury-----	{ Melvin (gray surfaced) Dunning (dark surfaced). Holly.
Medium to strongly acid materials washed principally from gray sandstone, shale, and quartzite.	-----	-----	Senecaville-----	-----
Medium to strongly acid materials washed principally from red shale and sandstone areas.	-----	-----	Schuylkill-----	-----
Coal fragments mixed in upper first or second foot of soil material.	-----	-----	-----	-----

¹ See footnote 8, p. 148, for a discussion of recent changes in theory concerning age of parent materials in these counties. According to concepts developed since this county was surveyed, some of the soil series would need to be combined. The report and map were too near completion to permit additional study before publication.

The Allenwood, Dewart, and Sedan soils have developed from glaciated gray acid shale, sandstone, and quartzite. The Fleetwood and Lycoming developed mainly from quartzite and sandstone, respectively; the Elliber and Mertz soils, mainly from cherty dolomitic limestone; and the Mazeppa and Norton, mainly from acid shale and quartzite. The Trexler and Springtown are from very strongly acid Jerseyan till, and the Reback from strongly acid pre-Wisconsin till.

With the exception of the Fleetwood and Lycoming soils, which occur in the forested mountainous areas, all of these soils are agricultural. They are moderately well supplied with organic matter and most plant nutrients. Their subsoils are friable or firm, and their water-holding capacity ranges from fair to excellent. Because of the favorable texture and consistence of both surface soils and subsoils, probably 90 percent of these soils are cleared and used for most of the crops grown in this section.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils of the uplands are characterized by their slowly pervious lower subsoil and substratum that check normal downward movement of water, air, and plant roots. The soils series in this group are the Alvira, Buchanan, Comly, Kreamer, Natalie, Turbotville, Warrior, Watson, and Wiltshire.

Compared with the well-drained soils, a slightly darker color in the surface layer, caused by a generally higher content of organic matter, is noticeable in most of these imperfectly drained soils. Oxidation is not so thorough in these soils, and soil-developing agencies do not so rapidly deplete them of plant nutrients and organic matter. In all of these soils, a mottled gray layer has been formed in some part of the solum, generally beginning just above the heaviest part of the subsoil. The depth of the friable yellowish or brownish material above this heavier textured more compact layer varies somewhat from place to place in each soil and among soils in the group. The Turbotville, Kreamer, Warrior, and Watson soils are friable to depths of 20 to 30 inches in most places and are somewhat superior in drainage conditions to the other soils, which have only 12 to 20 inches of friable soil material above the almost impervious layers.

The Turbotville and Wiltshire soils of this group are the richest in plant nutrients and the most productive of general crops. They are less acid than the others, owing to the influence of limestone and calcareous shale of the parent materials. The Kreamer soils were derived mainly from cherty limestone materials, now largely leached of lime. As they are only slightly deficient in drainage, Kreamer soils are adapted to nearly all crops, including potatoes and other vegetables. The Warrior, Watson, and Alvira soils were derived from gray and brown acid shale, sandstone, and quartzite. The Comly soils were derived largely from dark fine-textured shale. The Natalie soil, developed from acid gray quartzite, is nonagricultural and occurs in mountain areas. The Buchanan soil has developed from old colluvium washed from materials that weathered mainly from sandstone.

The slow or imperfect drainage of these soils is in some measure due to seepage water and subsoil compactness, but the chief cause is low relief. Most of them could be improved by artificial underdrainage, but they produce fair yields of most crops without this addi-

tional cost. They remain cold and wet late in the spring, however, and farming operations are thereby delayed. Deep-rooted plants such as alfalfa and fruit trees have an extremely limited use on these soils, and for optimum growth potatoes and other vegetables need better drainage than these soils have.

POORLY DRAINED SOILS

Only two series, the Lickdale and Shelmadine, represented by one soil type each, are included in this group of upland soils. They occupy low topographic positions that are subject to waterlogging and seepage from adjoining higher soils for prolonged periods during the year. During the spring and following heavy rains, these soils in many places remain covered for some time with shallow water. Basins having no natural outlets occur in some places, and in these areas the soil may remain moist or saturated most of the year. Oxidation and aeration of the soil material are low, as is indicated by the gray color of both the surface soil and subsoil.

The Lickdale soil is nonagricultural. It has developed largely from glacial till composed principally of sandstone and a smaller proportion of quartzite materials. In a few places the Lickdale soil has developed from colluvial material derived from the higher lying Rough stony land (Dekalb soil material). The Shelmadine soil occupies low positions in the agricultural areas of the two counties. It has developed from deep glacial till of acid sandstone, shale, and quartzite derivation. In many places the Shelmadine has developed on material that is partly of till and partly of colluvial origin.

SOILS OF TERRACES

The soils of the terraces are grouped according to drainage conditions as (1) well to excessively drained, (2) imperfectly drained, and (3) poorly drained soils.

WELL TO EXCESSIVELY DRAINED SOILS

The well to excessively drained soils of the terraces are the Chenango, Elkinsville, Lakin, Rushtown, and Wheeling. They are as well adapted to crops as the well-drained soils of the uplands. Their management and productivity vary considerably according to the source of the parent materials, as well as relief. All the soils are acid, but the parent materials of the Elkinsville soil were derived in part from calcareous materials, and as a result this soil is somewhat more productive of legumes. The Lakin soil has developed from rather light-textured wind-blown materials and is subject to drought in prolonged dry spells. The Rushtown soils have developed from shaly deposits and are also subject to drought and to erosion. The Wheeling soils have developed from somewhat deep sandy deposits overlying gravel and have a better moisture-holding capacity than the Chenango soils, which contain gravel within 36 inches or considerably less of the surface. The greater depth to gravel in the Wheeling soil is the principal difference between it and the Chenango soils.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils of the terraces are subject to a fluctuating water table, and their subsoil is characteristically mottled.

The soils in this group are members of the Chillisquaque, Pekin, Sciotoville, and Williamsburg series. The Chillisquaque soil has developed from neutral or slightly acid slack-water materials deposited over strongly acid materials, and the Williamsburg soil is derived from calcareous slack-water deposits. The Pekin and Sciotoville soils, associated with the Chenango and Elkinsville soils, have developed from a mixture of materials derived from sandstone, shale, and limestone. All of the soils of this group are adapted to hay and grass crops, and, except in very rainy seasons, to row crops.

POORLY AND VERY POORLY DRAINED SOILS

The poorly drained soils of the terraces occur in depressions. If they are adequately drained, row crops can be grown. The soil series in this group are the Bartle, Chilo, Dubois, Ginat, and Montgomery. The Bartle soil is derived from materials washed from the residuum of sandstone, shale, and limestone. The Ginat and Chilo soils have developed largely from materials of sandstone and shale derivation but contain some material from limestone. The Dubois soil has developed from strongly acid lacustrine materials. The Montgomery soil has formed from materials washed largely from glaciated limestone and calcareous shale areas.

SOILS OF BOTTOM LANDS

The soils of the bottom lands have developed from materials washed from the terraces and uplands. Their use for crops is determined by their susceptibility to overflow and their drainage conditions. They are grouped according to drainage into (1) well drained, (2) imperfectly drained, and (3) poorly drained soils.

WELL-DRAINED SOILS

The well-drained soils of the bottom lands are members of the Ashton, Huntington, and Tioga series. The natural fertility of these soils is very high, but crop production is somewhat limited by flooding. They are usually under water only a short time during floods, and subsequent runoff is rapid. The Ashton soils escape all except unusually high floods and are suited to almost as wide a range of crops as the well to excessively drained soils of the terraces or uplands.

IMPERFECTLY DRAINED SOILS

The imperfectly drained soils of the bottom lands have sufficient elevation to insure a dry surface soil most of the time; but the prevailing level of the ground water causes frequent saturation of the subsoil. This saturation is indicated by the gray or mixed gray and yellowish-brown colors. These soils are tillable, at least in part, and most of them are well suited to pasture grasses. The Lindside, Middlebury, Schuylkill, and Senecaville series make up this group.

POORLY DRAINED SOILS

The poorly drained soils of the bottom lands—those of the Dunning, Holly, and Melvin series—are of low productivity because of excessive moisture. They are subjected to flooding and remain saturated most of the time. A large part of their area is suitable for pastures.

MISCELLANEOUS LAND TYPES

Five miscellaneous land types have been mapped in this area. Two of these—Rough stony land (DeKalb soil material) and Rough stony land (Weikert soil material)—include land characterized by many bedrock outcrops that prevent tillage. Other conditions on these land types, such as steepness of slope, shallow depth of soil material, and low plant-nutrient content, are unsuitable for crops. Even timber growth is scant and scrubby. The three remaining miscellaneous land types are Made land, Mine dumps, and Riverwash (coal screenings), all of no agricultural value.

DESCRIPTIONS OF THE SOILS

The soils of Montour and Northumberland Counties are described in this section, and their suitability for agriculture is discussed. Their location is shown on the soil map accompanying this report. The approximate acreage and proportionate extent of the soils are given in table 4.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Montour and Northumberland Counties, Pa.*

Soil	Montour		Northumberland	
	<i>Acres</i>	<i>Percent</i>	<i>Acres</i>	<i>Percent</i>
Allenwood gravelly silt loam.....	1, 006	1. 2	1, 563	0. 5
Eroded rolling phase.....	158	. 2	336	. 1
Allenwood silt loam.....	317	. 4	1, 411	. 5
Eroded phase.....	361	. 4	1, 150	. 4
Eroded rolling phase.....	132	. 2	699	. 2
Alvira silt loam.....	1, 636	1. 9	2, 571	. 9
Ashton fine sandy loam.....			1, 119	. 4
Ashton silt loam.....			622	. 2
Bartle silt loam.....	3, 028	3. 6	500	. 2
Buchanan stony loam.....			1, 409	. 5
Chenango gravelly loam.....			860	. 3
Chenango sandy loam.....	47	. 1	913	. 3
Chillisquaque silt loam.....	83	. 1	633	. 2
Chilo loam.....			105	(¹)
Comly silt loam:				
Eroded phase.....	2, 942	3. 5	2, 277	. 8
Eroded sloping phase.....	609	. 7	499	. 2
Crestmore silt loam.....	129	. 2	95	(¹)
Eroded hilly phase.....	200	. 2	125	(¹)
Eroded sloping phase.....	48	. 1	308	. 1
Dewart gravelly silt loam.....	380	. 4	2, 341	. 8
Eroded rolling phase.....	139	. 2	943	. 3
Dewart sandy loam, eroded phase.....			419	. 1
Dewart silt loam.....	300	. 4	471	. 2
Dubois silt loam.....	1, 191	1. 4	2, 173	. 8
Dunning silty clay loam.....	231	. 3	236	. 1
Elkinsville silt loam.....	331	. 4	525	. 2
Elliber cherty silt loam.....	107	. 1	293	. 1
Hill phase.....	39	(¹)	345	. 1
Rolling phase.....	39	(¹)	178	. 1
Fleetwood channery loam, shallow phase.....			46	(¹)
Fleetwood stony loam.....			5, 385	1. 8
Gently rolling phase.....			5, 278	1. 8
Hilly phase.....			1, 835	. 6
Shallow phase.....			2, 146	. 7
Ginat sandy loam.....			772	. 3

¹ Less than 0.1 percent.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Montour and Northumberland Counties, Pa.—Con.*

Soil	Montour		Northumberland	
	<i>Acres</i>	<i>Percent</i> (¹)	<i>Acres</i>	<i>Percent</i>
Ginat silt loam.....	15		663	0.2
Hagerstown silt loam:				
Eroded hill shallow phase.....	508	.6	551	.2
Eroded shallow phase.....	367	.4	217	.1
Eroded sloping shallow phase.....	265	.3	262	.1
Hartleton channery silt loam.....	2,361	2.8	4,562	1.6
Eroded hilly phase.....	571	.7	1,101	.4
Eroded rolling phase.....	3,884	4.7	4,262	1.5
Eroded phase.....	954	1.1	2,632	.9
Hilly phase.....	290	.3	648	.2
Holly silt loam.....	537	.6	748	.3
Huntington sandy loam.....			1,446	.5
Huntington silt loam.....	130	.2	167	.1
Kistler shaly silt loam.....	224	.3	603	.2
Eroded hilly phase.....	1,445	1.7	790	.3
Eroded phase.....	453	.5	524	.2
Eroded rolling phase.....	1,150	1.4	567	.2
Hilly phase.....	173	.2	336	.1
Rolling phase.....	59	.1	60	(¹)
Klinesville gravelly silt loam:				
Eroded hill phase.....			1,603	.6
Eroded phase.....			1,086	.4
Eroded undulating phase.....	61	.1	1,253	.4
Undulating phase.....			231	.1
Klinesville shaly silt loam:				
Eroded hill phase.....	216	.3	2,481	.8
Eroded phase.....	208	.2	1,705	.6
Eroded steep phase.....	174	.2	2,880	1.0
Eroded undulating phase.....	21	(¹)	1,371	.5
Undulating phase.....	31	(¹)	772	.3
Klinesville stony loam.....	18	(¹)	216	.1
Kreamer cherty silt loam:				
Eroded hilly phase.....			377	.1
Eroded phase.....	305	.4	3,578	1.2
Eroded rolling phase.....	302	.4	974	.3
Kutztown shaly silt loam:				
Eroded hill phase.....	244	.3	1,473	.5
Eroded phase.....	157	.2	1,284	.4
Eroded sloping phase.....	118	.1	720	.2
Gently sloping phase.....	31	(¹)	516	.2
Lakin loamy fine sand.....			1,731	.6
Leck Kill channery silt loam.....	168	.2	2,930	1.0
Eroded hilly phase.....	210	.2	3,399	1.2
Eroded phase.....	97	.1	5,136	1.8
Eroded rolling phase.....	542	.6	5,941	2.0
Leetonia stony loamy coarse sand.....			3,209	1.1
Lickdale stony silt loam.....			797	.3
Lindside sandy loam.....			379	.1
Lindside silt loam.....	2,235	2.6	3,286	1.1
Lycoming stony loam.....			2,106	.7
Made land.....	79	.1	13	(¹)
Mazeppa silt loam.....	288	.3	1,183	.4
Eroded rolling phase.....	138	.2	587	.2
Melvin sandy loam.....			390	.1
Melvin silt loam.....	802	.9	1,667	.6
Mertz cherty silt loam.....	269	.3	400	.1
Eroded hill phase.....	674	.8	642	.2
Eroded phase.....	224	.3	199	.1
Eroded rolling phase.....	464	.5	254	.1
Rolling phase.....	82	.1	292	.1

¹ Less than 0.1 percent.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Montour and Northumberland Counties, Pa.—Con.*

Soil	Montour		Northumberland	
	<i>Acres</i>	<i>Percent</i>	<i>Acres</i>	<i>Percent</i>
Middlebury silt loam.....	2, 756	3. 3	4, 749	1. 6
Mifflinburg silt loam.....	293	. 3	603	. 2
Eroded phase.....	512	. 6	2, 896	1. 0
Eroded rolling phase.....	486	. 6	1, 631	. 6
Mine dumps.....	154	. 2	5, 591	1. 9
Montgomery silty clay loam.....	311	. 4	395	. 1
Natalie stony silt loam.....			1, 587	. 5
Northumberland shaly silt loam:				
Eroded hill phase.....	182	. 2	550	. 2
Eroded phase.....	76	. 1	314	. 1
Eroded rolling phase.....	96	. 1	832	. 3
Norton gravelly loam.....	36	(¹)	1, 216	. 4
Eroded phase.....	11	(¹)	3, 931	1. 4
Eroded sloping phase.....	344	. 4	2, 886	1. 0
Sloping phase.....	156	. 2		
Norton silt loam.....	216	. 3	2, 401	. 8
Eroded phase.....	86	. 1	4, 641	1. 6
Pekin silt loam.....	2, 852	3. 4	1, 468	. 5
Rebuck silt loam.....	269	. 3	1, 216	. 4
Eroded phase.....	402	. 5	2, 159	. 7
Riverwash (coal screenings).....	16	(¹)	1, 565	. 5
Rough stony land (DeKalb soil material).....	1, 828	2. 2	26, 219	9. 0
Rough stony land (Weikert soil material).....	255	. 3	845	. 3
Rushtown shaly silt loam.....	2	(¹)	1, 789	. 6
Eroded rolling phase.....	33	(¹)	1, 065	. 4
Ryder silt loam.....	353	. 4		
Schuylkill silt loam.....	290	. 3	3, 936	1. 4
Sciotoville sandy loam.....	29	(¹)	1, 266	. 4
Sciotoville silt loam.....	265	. 3	720	. 2
Sedan cherty silt loam.....	249	. 3	18	(¹)
Eroded phase.....	370	. 4		
Eroded rolling phase.....	612	. 7	200	. 1
Sedan gravelly silt loam, eroded phase.....			286	. 1
Senecaville silt loam.....	60	. 1	3, 649	1. 2
Shelmadine silt loam.....	1, 277	1. 5	1, 521	. 5
Springtown stony loam, hill phase.....			2, 924	1. 0
Springtown stony loam.....			1, 032	. 4
Stephensburg shaly silt loam.....	960	1. 1	814	. 3
Eroded hilly phase.....	320	. 4	547	. 2
Eroded phase.....	2, 198	2. 6	472	. 2
Eroded rolling phase.....	1, 414	1. 7	991	. 3
Tioga sandy loam.....	69	. 1	589	. 2
Tioga silt loam.....	176	. 2	1, 043	. 4
Trexler channery silt loam.....			1, 991	. 7
Eroded hilly phase.....			810	. 3
Eroded phase.....			2, 602	. 9
Eroded rolling phase.....			1, 302	. 4
Rolling phase.....			983	. 3
Trexler channery loam.....			1, 472	. 5
Eroded phase.....			1, 071	. 4
Steep phase.....			3, 004	1. 0
Trexler gravelly silt loam.....			265	. 1
Turbotville silt loam.....	323	. 4	320	. 1
Eroded gently rolling phase.....	133	. 2	47	(¹)
Eroded phase.....	395	. 5	551	. 2
Warrior gravelly silt loam.....	946	1. 1	745	. 3
Eroded phase.....	1, 523	1. 8	1, 879	. 6
Eroded sloping phase.....	493	. 6	1, 514	. 5

¹ Less than 0.1 percent.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Montour and Northumberland Counties, Pa.—Con.*

Soil	Montour		Northumberland	
	<i>Acres</i>	<i>Percent</i>	<i>Acres</i>	<i>Percent</i>
Washington gravelly silt loam.....	14	(¹)	-----	-----
Eroded phase.....	501	. 6	136	. 1
Washington silt loam.....	232	. 3	570	. 2
Eroded phase.....	877	1. 0	2, 507	. 9
Eroded rolling phase.....	1, 065	1. 3	622	. 2
Watson gravelly silt loam.....	670	. 8	913	. 3
Eroded phase.....	1, 232	1. 5	2, 607	. 9
Eroded sloping phase.....	1, 282	1. 5	1, 747	. 6
Strongly sloping phase.....	243	. 3	220	. 1
Watson stony loam.....	62	. 1	1, 009	. 4
Strongly sloping phase.....	34	(¹)	993	. 3
Weikert channery silt loam.....	1, 791	2. 1	3, 788	1. 3
Hilly phase.....	3, 093	3. 7	7, 732	2. 7
Eroded hilly phase.....	2, 691	3. 2	6, 286	2. 2
Eroded rolling phase.....	1, 202	1. 4	2, 573	. 9
Eroded steep phase.....	1, 265	1. 5	4, 158	1. 4
Rolling phase.....	1, 095	1. 3	4, 239	1. 4
Steep phase.....	4, 165	5. 0	8, 490	2. 9
Very steep phase.....	1, 290	1. 5	5, 421	1. 9
Weikert flaggy loam.....	44	. 1	581	. 2
Weikert shaly silt loam.....	272	. 3	1, 553	. 5
Eroded rolling phase.....	37	(¹)	523	. 2
Rolling phase.....	71	. 1	913	. 3
Wheeling sandy loam.....	-----	-----	2, 860	1. 0
Eroded strongly sloping phase.....	242	. 3	396	. 1
Wheeling loam.....	841	1. 0	1, 525	. 5
Wheeling silt loam:				
Eroded shallow phase.....	87	. 1	488	. 2
Eroded strongly sloping shallow phase.....	62	. 1	565	. 2
Williamsburg silt loam.....	915	1. 1	426	. 2
Wiltshire silt loam.....	281	. 3	739	. 2
'Total.....	84, 480	100. 0	291, 475	100. 0

¹ Less than 0.1 percent.

Allenwood gravelly silt loam (3-12% slopes) (A₄).—Except for the larger quantity of angular sandstone and shale fragments mixed with the soil material, this gravelly silt loam is essentially the same as Allenwood silt loam. The coarser material interferes only slightly with tillage. In use, yields, and requirements for maintaining productivity, the two soil types are very much alike. Included with this soil are several small scattered areas where the entire soil is moderately shaly and moisture conditions are not quite so good. On these spots slightly lower yields than on Allenwood silt loam can be expected.

Use and management.—This soil is permeable to roots and moisture. It is well suited to crops and pasture but proper crop rotation and fertilization are necessary to maintain satisfactory yields. A rotation of moderate length that includes a deep-rooted legume is desirable. The soil is deficient in calcium, nitrogen, phosphorus, and potassium, which must be supplied for high crop yields. For suggested rotations see management subgroup 1B in table 5.

Allenwood gravelly silt loam, eroded rolling phase (12–20% slopes) (Ab).—Small tracts of this widely scattered soil occur over most of the area. The soil is similar to Allenwood silt loam in profile characteristics, except in having more angular fragments of shale and sandstone and in being more eroded. Because of its slope, considerable care should be exercised in management to prevent further erosion.

Use and management.—At the time of survey about 85 percent of Allenwood gravelly silt loam, eroded rolling phase, was used for general crops, soybeans, and alfalfa. The rest was in pasture or forest or lying idle. Yields are about 5 to 10 percent lower than those ordinarily obtained on Allenwood silt loam. Erosion is moderate in most areas, though a few fields are severely eroded. Shallow gullies are evident in most fields. Two years of hay are more effective in a rotation than one in controlling runoff and erosion. Contour strip cropping will make possible more intensive use of the soil. Also, properly laid out and constructed terraces on lesser slopes may be effective in some fields. See management subgroup 2B in table 6 for suitable management practices.

Allenwood silt loam (3–12% slopes) (Ac).—This well-drained deep soil has developed on pre-Wisconsin till and residuum derived principally from acid gray shale, sandstone, and quartzite. It occurs on undulating to moderately rolling relief in small scattered areas throughout the upland in association with the imperfectly drained Watson and Alvira soils and the poorly drained Shelmadine soil, which developed on similar parent material. This silt loam is one of the most extensive deep soils in the area.

Throughout the upland the typical surface layer consists of 6 to 8 inches of brown to light brown friable silt loam, darkened by a fair supply of organic matter. From a depth of 8 to 15 inches is light yellowish-brown friable heavy silt loam. The friability of this layer is partly caused by grit, gravel, and coarse materials, but the finer textured constituents tend to cause structure that is favorable to good water-holding properties. The lower subsoil is yellowish-brown weakly platy friable silty clay loam. The material underlying it is yellowish-brown or yellowish-red partially weathered friable but slightly compact glacial till of pre-Wisconsin age. Angular gravel and shale fragments occur in small quantities throughout the soil and parent material, but they do not interfere with tillage.

Both the surface soil and subsoil are very strongly acid. The water-holding capacity of this soil is high, yet the material throughout is permeable to plant roots, air, and moisture. Where crops have been grown, from one-fourth to one-half of the original surface layer has been lost through erosion. Included with this soil in mapping are several areas where the surface soil is a loam and the subsoil is a sandy clay.

Use and management.—Owing to its mild relief nearly all of Allenwood silt loam has been cleared. At the time of survey about 90 percent was used for crops, 5 percent was in woodlots and pasture, and 5 percent was idle. The soil is well suited to all crops, especially to potatoes and tomatoes. Corn, wheat, oats, potatoes, and hay are grown extensively.

Special management requirements are use of lime and mineral plant nutrients, increase in supply of humus, and proper choice and rotation of crops. Tillage can be accomplished over a fairly wide range of moisture content without seriously impairing tilth. Alfalfa can be grown successfully if the soil is limed and heavily fertilized. Legumes, especially the deep-rooted kind, should be included in the rotation to supply humus, improve tilth, and control runoff. This soil is in management subgroup 1B, as shown in table 5.

Allenwood silt loam, eroded phase (3–12% slopes) (Ad).—Because it has been eroded, this phase is mapped separately from Allenwood silt loam. From one-half to three-fourths of its original surface soil has been lost, and there are shallow gullies, usually more than 100 feet apart. In a few places the gullies are closer together and interfere to some extent with tillage. Although its slope range is the same as for Allenwood silt loam, this phase requires more care to control erosion.

Use and management.—At the time of survey about 95 percent of this soil was cleared; the remaining 5 percent was partly in pasture and partly abandoned. The cleared areas are used for all crops grown in this section. Crop yields range from nearly the same as on Allenwood silt loam to about 5 percent lower. In suitability to crops and treatments needed the two soils are similar. This phase, however, is somewhat lower in plant nutrients and organic matter than Allenwood silt loam. It nevertheless responds well to good management. A somewhat longer rotation in which more legumes are included is required to maintain fertility and control erosion than is necessary for Allenwood silt loam. See subgroup 1B in table 5 for suitable management practices.

Allenwood silt loam, eroded rolling phase (12–20% slopes) (Ae).—This soil occupies strongly rolling areas in association with the other Allenwood soils. Except for steeper slopes, and a slightly thinner surface layer, it has characteristics similar to those of Allenwood silt loam. Gullies are common, and from one-fourth to three-fourths of the surface soil has been lost in cleared areas.

Use and management.—At the time of survey about 70 percent of this soil was used for cultivated crops, 15 percent was idle, 10 percent was in pasture, and 5 percent was wooded. Yields of crops are about 5 to 10 percent below those obtained on Allenwood silt loam.

The soil is well suited to field crops and pasture plants commonly grown in the area. It is less desirable, however, than Allenwood silt loam. It requires more exacting management, for it is lower in nutrients and organic matter, slightly lower in water-holding capacity, and more susceptible to erosion. Keeping crop yields at a satisfactory level will require moderate to long rotations that include legumes and grasses, as well as rather heavy applications of phosphorus. Suitable rotations are given in subgroup 2B of table 6.

Alvira silt loam (2–7% slopes) (Af).—This imperfectly drained soil developed on pre-Wisconsin glacial till derived principally from acid gray shale, sandstone, and quartzite. It occupies lower slopes in the valleys of the two counties. Associated with it are the well-drained Allenwood and Dewart, the imperfectly drained Watson and Warrior, and the poorly drained Shelmadine soils. The Alvira

soil differs from the Watson and Warrior soils in not having an especially compact lower subsoil. Most of it occurs north of Montour Ridge. Small scattered areas are found also in swales and low places in other parts of the area. Seepage water from many higher lying slopes keeps this soil wet until late in spring.

The surface soil consists of 6 to 10 inches of moderately dark grayish-brown mellow silt loam fairly well supplied with organic matter. The upper subsoil, extending to depths of 12 to 20 inches, is light yellowish-brown firm heavy silt loam that has good moisture-holding properties and is well aerated. Below this, poor oxidation is indicated by the heavier, slightly compact, and mottled gray and yellow material. The lower subsoil is only slowly permeable to water and plant roots and is frequently saturated because of the fluctuating water table.

The few angular sandstone and shale fragments mixed with the soil interfere with tillage in only a few places. These areas are indicated on the map by gravel symbols. This silt loam is very strongly acid and comparatively low in plant nutrients. Crop yields are generally poor to fair.

Use and management.—At the time of survey about 60 percent of Alvira silt loam was in crops, 25 percent in forest, 5 percent in pasture, and the rest idle. Timothy, oats, alsike clover, and pasture grasses are better adapted to this soil than corn, wheat, red clover, alfalfa, or vegetables. Thawing and freezing of this soil cause alfalfa and wheat to heave considerably.

A system of deep drainage ditches would benefit this soil and make it adaptable to more crops. It is doubtful, however, that an elaborate system for artificial drainage would pay for itself in higher yields. Erosion is only slight to moderate but probably would be lessened by artificial drainage, which would accelerate percolation and decrease runoff. Most of the common field crops except alfalfa are fairly well suited. Adequate applications of lime, phosphorus, nitrogen, and potassium are the chief requirements for maintaining good yields. See management subgroup 5B in table 9 for suggested management of this soil.

Ashton fine sandy loam (0-3% slopes) (Ag).—Although otherwise much alike, this soil and Ashton silt loam are differentiated on the basis of texture. The relation between them is the same as that between the two Huntington soil types mapped in these counties. Nearly all of Ashton fine sandy loam is north of Chillisquaque Creek on the high bottoms of the West Branch of the Susquehanna River, but a few tracts are south of Sunbury on the Susquehanna River bottoms. The soil lies from 15 to 25 feet above the normal river level and is overflowed only during abnormally high floods, which occur about once in 10 years. Damage to crops is slight, since the water moves slowly and most of the soil is a considerable distance from the river.

This soil has a moderate-brown porous fine sandy loam surface soil 8 to 12 inches deep. Below this is moderate- to strong-brown friable loam to sandy clay, 24 to 30 inches deep. The substratum is more sandy; its texture ranges from loamy sand to loam. In some places the surface soil is heavier than typical, or has a loam texture. The separation of Ashton fine sandy loam from Ashton silt loam is more

or less arbitrary in places, as one grades gradually into the other. Also, separation of this fine sandy loam from Huntington sandy loam is difficult in places, for the two soils differ but little in profile characteristics.

Ashton fine sandy loam, like Ashton silt loam and the Huntington soils, is comparatively well supplied with plant nutrients. It varies from slightly to moderately acid in both the surface soil and subsoil. Although it does not have the capacity to store as large a quantity of water as the finer textured Ashton and Huntington silt loams, it is by no means droughty. The moderate to liberal supply of organic matter aids in the retention of water.

Use and management.—At the time of survey practically all of Ashton fine sandy loam had been cleared, and, except for areas covered by town property, was being used for crops. General crops, alfalfa, soybeans, and vegetables are grown. Corn, oats, soybeans, alfalfa, potatoes, and vegetables are somewhat better suited than wheat, timothy, and clover.

This soil responds well to fertilization. Since it has favorable tilth and moisture relations, fairly large yields can be produced consistently if the supply of organic matter and plant nutrients is maintained. Phosphate and potash fertilizer likely will be needed for all crops, and some nitrogen for nonlegume crops. Small quantities of lime are needed for red clover and alfalfa. No special practices for controlling runoff are necessary. Suitable management practices for this soil are suggested in subgroup 6A of table 10.

Ashton silt loam (0–3% slopes) (AH).—This well-drained soil has developed on high bottoms that are infrequently flooded. Many farm homes are built on the soil, and flood damage to buildings and crops occurs only about once every 15 to 20 years. The parent materials were washed from areas where the underlying rocks are principally limestone, sandstone, and shale. Nearly all of this soil occurs on the West Branch of the Susquehanna River. It is closely associated with the lower lying well-drained Huntington, the imperfectly drained Lindsides, the poorly drained Melvin, and the very poorly drained Dunning soils—all of which have developed from similar materials. It differs from Huntington silt loam in being leached to a greater extent and in having more subsoil development. These differences are not so great as to cause material differences in fertility, and crop yields are nearly the same on this soil as on Huntington silt loam. Fall-sown crops on this soil, however, stand less risk of being damaged by overflow.

The surface soil is a moderate-brown mellow silt loam, 8 to 10 inches deep. From a depth 10 inches down to 30 inches the subsoil is a moderate- to strong-brown friable but moderately firm silty clay loam. With increase in depth the material becomes somewhat lighter in texture and color. Underdrainage is adequate in most places. In a few places, however, gray mottling appears at 30 to 36 inches and the lower subsoil remains saturated following wet spells longer than in the typical soil.

Use and management.—The productivity and workability of Ashton silt loam are good; the soil is suited to practically all crops grown in this section. At the time of survey at least 95 percent of it was used for crops, and the rest was in pasture and forest. Wheat, oats,

and soybeans do not lodge quite so much as they do on Huntington silt loam. Legumes thrive better on this soil than on any of those derived entirely from acid materials. Applications of lime benefit clover and alfalfa, as in most places this soil is moderately acid.

Physically, the soil is suited to intensive use for crops; it is not difficult to conserve soil materials and fertility from losses through erosion and leaching. Tomatoes and potatoes return good yields. Some tobacco is produced; 1,200 to 1,400 pounds of good quality tobacco an acre are obtained. Complete fertilizer is needed to maintain high yields. Moisture conditions favor both the application of large quantities of plant nutrients and their efficient use by plants. Management practices for this soil are suggested under subgroup 6A in table 10.

Bartle silt loam (0-3% slopes) (B_A).—As it occupies almost level or depressed positions on the terraces along the creeks of the two counties, this soil has developed under poor drainage conditions. It is associated with the imperfectly drained Pekin soil and the well-drained Elkinsville soil. Practically all of it is above flood level, but some of it receives seepage and drainage water from higher lying areas. Owing to the level surface, excess water drains away very slowly and the surface soil and subsoil remain wet long after rains. The soil materials are fine-textured deposits washed from areas underlain by acid shale and sandstone.

The 8- to 10-inch surface soil is a light-gray or light yellowish-gray very friable silt loam moderately well supplied with organic matter. The silty clay loam to clay subsoil—dominantly gray or drab, with yellowish brown mottlings—is slightly plastic when wet and compact when dry. It is almost impervious to roots, air, and moisture. The substratum consists of noncalcareous water-laid deposits of silt, clay, and very fine sand.

An area of about 50 acres northwest of Strawberry Ridge has a 12- to 16-inch brownish-black surface layer that is high in organic matter. Because of its small area, it is included with Bartle silt loam.

Bartle silt loam contains a moderate supply of most plant nutrients, but they are largely inaccessible to plant roots because of restricted drainage. The calcium content is low, and the soil is strongly to very strongly acid throughout where lime is not used regularly. Tilth conditions are good after excess water has gone. There is very little gravel in the surface soil or subsoil.

Use and management.—At the time of survey about 65 percent of Bartle silt loam was used for crops, 15 percent was in forest, 15 percent was used seasonally as permanent pasture, and about 5 percent was abandoned or idle. Crop yields are similar to those on Ginat silt loam. Oats, timothy, and pasture grasses are better suited to this soil than other crops, which frequently drown out in spring or freeze in the colder months. Even with artificial drainage, alfalfa will not succeed, as roots cannot penetrate deep enough. Alsike clover grows considerably better than red clover.

This soil has poor drainage and therefore may not show so good a response to soil treatments as associated soils with better drainage. Nevertheless pasture and adapted crops can be improved by using lime, phosphorus, and potassium. Some nitrogen may benefit special non-

legume crops. See subgroup 5C in table 9 for suggested management practices.

Without tile drainage this soil cannot be managed satisfactorily, and no other beneficial soil treatment can be fully effective. Results on soils with similar texture and relief indicate that tile lines laid at a depth of 30 inches and not over 4 rods apart will give satisfactory results for general crops.

Buchanan stony loam (4–20% slopes) (Bb).—This imperfectly drained soil has developed on colluvial materials derived principally from acid gray sandstone. It occurs as small scattered strips at the base of several mountains in the southeastern part of Northumberland County. It is associated with the well-drained Lycoming soil and the poorly drained Lickdale soil that have developed on similar material.

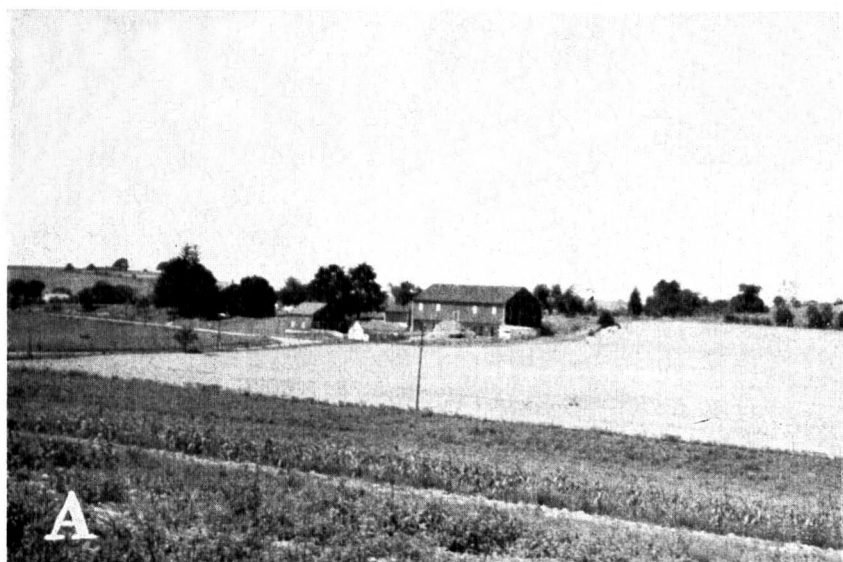
The surface soil is grayish-yellow friable porous stony loam, 6 or 8 inches deep. The upper part is stained dark with organic matter. Between depths of 8 and 16 inches occurs light-yellow to light yellowish-brown friable gritty loam. The lower subsoil, a mottled gray and yellow loam to silt loam, is sticky when wet but friable when dry. In a few places the lower subsoil is a slightly compact fine sandy clay. Numerous gray stones and rocks are strewn over the surface and imbedded in the subsoil. These coarse fragments, as well as other unfavorable conditions, make clearing and cultivation impractical.

Although runoff is adequate, subsoil drainage is restricted. Plant roots do not often penetrate below 20 or 24 inches. This depth is variable, however, and in places the soil shows the gray mottlings that indicate poor drainage at depths of 10 to 12 inches. Seepage water from higher lying slopes keeps the lower subsoil wet for a large part of the year.

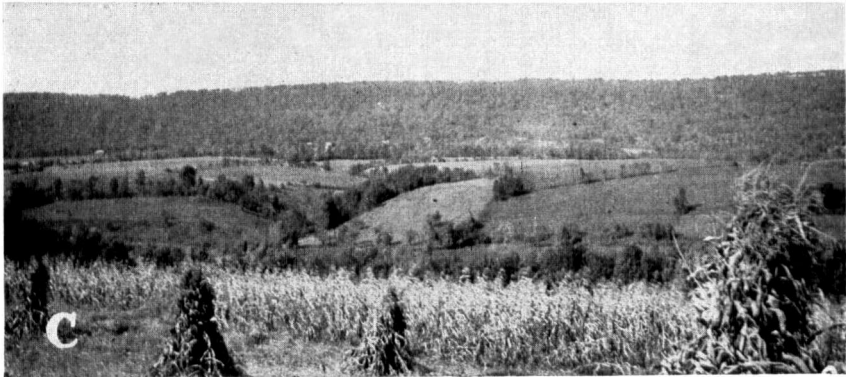
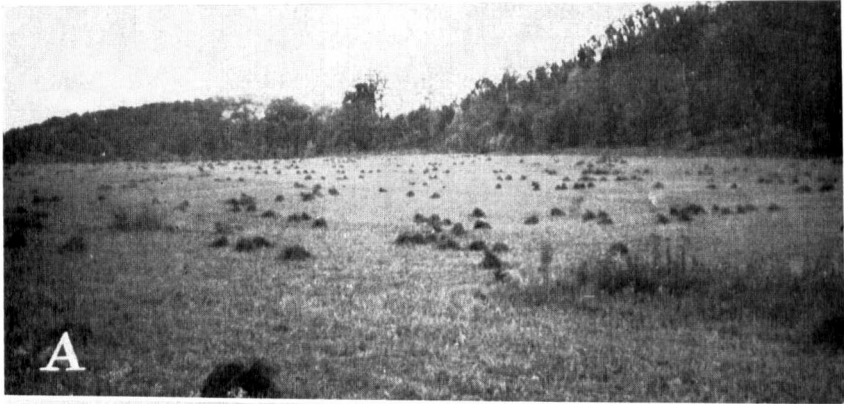
Use and management.—This soil is extremely acid in all layers. As it is low in organic matter and other plant nutrients, it has remained in forest, its best use. The trees are white, black, and chestnut oaks, red maple, elm, hickory, dogwood, and poplar, with an undergrowth of sassafras, mountain-laurel, huckleberry, fern, and moss. See management group 9 in table 13 for suggested management of this soil.

Chenango gravelly loam (0–8% slopes) (Ca).—Most of this soil is on terraces along the North Branch of the Susquehanna River. Relief is level to undulating (pl. 2, A). The areas are generally 30 to 75 feet above the river, or considerably above flood level. The gravelly materials from which the soil developed were washed from areas of sandstone, shale, and quartzite. Probably they were deposited during or since the Wisconsin glaciation. The Chenango soils differ from the Wheeling soils principally in having a subsoil that is not so well developed and gravelly layers that occur nearer the surface.

The surface soil consists of a rather loose grayish-brown loam that contains many rounded sandstone, shale, or quartzite pebbles and some rounded stones. About one-fourth to one-half of the original surface soil has been removed by erosion. Beneath the surface layer and continuing to a depth of about 24 inches is yellowish-brown sandy clay subsoil, which contains some gravel but is friable and heavy enough to retain considerable water. This part of the subsoil is readily penetrated by plant roots and air. The lower part of the subsoil, consisting of coarser textured gravel and sandy loam, continues to depths of 8 to 10 feet. Water rapidly percolates through this coarser material.



A, Typical farmstead of Mifflinburg soils about 2½ miles east of Milton on undulating to rolling relief characteristic of these soils.
B, Looking north across undulating and rolling Leck Kill and Rebuck soils. Montour Ridge in distance; North Branch Susquehanna River Valley (too low to show) at base of mountain.



A, Buckwheat on Chenango gravelly loam. This is an excellent soil for corn, oats, potatoes, and vegetables.
B, Wheat on Hartleton channery silt loam about 1 mle west of New Columbia.
C, Dark field left center is on Klinesville gravelly silt loam, eroded hill phase. This soil is shallow and hilly and the field is therefore abandoned. Rolling and undulating areas in middle distance are Norton gravelly loam.

The subsoil and substratum are very strongly acid. In many places, however, the acidity of the surface soil has been corrected to some extent by adding lime. The supply of organic matter and other plant nutrients is moderate. The soil is slightly more susceptible to drought than Wheeling loam, for the thickness of its finer textured layers is less. Chenango gravelly loam absorbs rainfall rapidly; consequently, there is little runoff.

Use and management.—Practically all of this soil was brought under cultivation during early settlement. Some of it is now occupied by towns. At the time of survey probably 5 percent was in pasture grasses and 5 percent was idle. General crops, soybeans, and vegetables are largely grown. This soil is especially well suited to corn, potatoes and tomatoes, but wheat, rye or pasture grasses are fairly well suited.

The soil is suited to intensive cropping, particularly to inter-tilled crops, if it is adequately fertilized and limed and its organic-matter content is maintained by plowing in crop residues, green manure, or barnyard manure. Management practices are suggested in subgroup 1C of table 5.

Chenango sandy loam (0-8% slopes) (C_B).—The almost level to undulating areas of this soil occur on the terraces along the two main branches of the Susquehanna River.

The surface soil, a light-brown porous sandy loam or fine sandy loam, contains some pieces of rounded sandstone, shale, and quartzite gravel. Below 10 inches is yellowish-brown friable loam, 15 to 40 percent of which consists of rounded pebbles. Encountered at depths of 20 to 24 inches are bedded loose sands and fine gravel. There is very little runoff from this soil, as all the layers are porous and under-drainage is rapid. Erosion is only slight in most places.

Use and management.—Nearly all this sandy soil is cleared; most of it is used for general crops and potatoes and other vegetables. Crop yields are lower than on Chenango gravelly loam because the water-holding capacity is less. Crops are damaged to greater extent during prolonged dry spells. Nevertheless, this is an excellent vegetable soil if manure and fertilizer are applied frequently. Vegetables mature early and are of good quality. Alfalfa and fruit trees also return good yields if lime and fertilizer are used. Alfalfa improves the physical condition of the subsoil; the residue left by its decaying roots adds organic matter and nitrogen.

Simple practices will control erosion. The main requirements for soil improvement are use of proper crop rotations, application of necessary amendments, and increasing the organic content of the soil. See management subgroup 1C in table 5 for suitable management practices.

Chillisquaque silt loam (0-5% slopes) (C_C).—This imperfectly drained almost level to gently undulating soil is associated with the Williamsburg and Montgomery soils. In many places, however, it occurs on relatively old glacial lake beds rather than on stream terraces. The acid silt and clay of the substratum were deposited by slack water, probably during a pre-Wisconsin glacial period. In contrast, the material from which the upper part of the profile has developed is a subsequent limestone-influenced colluvial deposit derived from the surrounding uplands.

The surface soil to a depth of 7 or 8 inches is dark-grayish brown friable silt loam. This is underlain to depths of 12 to 15 inches by light yellowish-brown silt loam. The lower subsoil is mottled light-gray, yellowish-brown, and strong-brown slightly compact but friable silty clay loam. Below 36 or 40 inches occur light-gray less weathered silty water-laid deposits.

The surface soil is somewhat darker than that of nearby soils developed under similar drainage. Possibly this is the result of its neutral or mildly alkaline reaction and the presence of small limestone fragments. The upper subsoil is neutral to moderately acid; the lower subsoil, strongly acid in most places. The organic-matter content is moderate to good, tilth conditions are good, and erosion is negligible. Surface drainage is good, but internal drainage is slow, and few plant roots penetrate below 24 inches.

Use and management.—In productivity this soil is intermediate between the Pekin and Williamsburg soils. More than 90 percent of it was used for general crops and soybeans at the time of survey. Small areas were in forest or idle. The soil is not suited to fruit trees and alfalfa.

If adequately fertilized, this soil can be used intensively for crops. It requires lime, phosphorus, and potash to maintain high yields. Though it is relatively high in organic matter and nitrogen, increased yields of nonlegume crops can be expected from applications of nitrogen fertilizer. Suitable management practices are listed under group 5A in table 9.

Chilo loam (0-3% slopes) (Cd).—This soil occupies level or depressed areas on the North Branch of the Susquehanna River terraces. It is associated with the well-drained Wheeling, the imperfectly drained Sciotoville, and the poorly drained Ginat soils, which have developed from similar parent materials.

This poorly drained dark-surfaced soil has developed from medium-textured yellowish-brown acid material, which is underlain by gravel at depths of 3 to 5 feet in most places. The materials came principally from sandstone and shale areas, but a small part may be of limestone origin.

The surface soil, ranging to depths of 12 to 15 inches, is very dark-gray to almost black mellow sandy loam to loam. The subsoil is moderate-gray sticky slightly plastic sandy clay that shows a few splotches of yellowish brown. At a depth of about 30 inches this material grades into mottled gray and brown very fine sandy loam that becomes coarser textured at 5 or 6 feet. The dark color of the surface soil is caused by a large accumulation of moderately well decomposed organic matter that has been mixed with the mineral soil particles. Both the surface soil and subsoil are free of gravel, but the substratum usually contains some water-rounded gravel.

This soil has a considerable darker surface layer and is generally more poorly drained than Ginat silt loam. In dry seasons the surface soil is comparatively dry, since the water table fluctuates to a small extent. The subsoil, however, remains saturated most of the year. The level or depressed position of this soil, not the texture of its layers, causes the very poor drainage. Its subsoil and substratum are texturally and structurally suited to rapid water movement. The

soil is strongly to very strongly acid and rather low in most plant nutrients except organic matter and nitrogen.

Use and management.—At the time of survey about two-thirds of Chilo loam was in forest, and one-third had been cleared and largely abandoned. Artificial drainage would not be difficult if adequate outlets could be provided. Management practices are suggested for this soil under subgroup 5C in table 9.

Comly silt loam, eroded phase (2–6% slopes) (Ce).—This imperfectly drained soil has developed from pre-Wisconsin till and residuum that came from dark-gray or black shale. The scattered areas are undulating to gently rolling. From one-half to three-fourths of the original surface soil has been removed, even on the slopes of slight gradient. The soil is associated with the Stephensburg and Kistler soils.

The 6- to 8-inch surface soil is grayish-brown very friable silt loam. The upper subsoil is yellowish-brown friable heavy silt loam. Underlying this is a mottled gray and light yellowish-brown layer. This mottled layer, friable when dry but slightly plastic when wet, is only slowly permeable to water and air. In general it is too wet most of the year to be penetrated by plant roots. Weathered thin-bedded black Marcellus shale underlies the soil material at depths of 24 to 36 inches in most places. At depths of 6 to 10 feet there is evidence of carbonates.

The soil has low organic-matter content and is strongly acid in places where no lime is used. Surface drainage is good, but internal drainage is impeded by the grayish heavy subsoil and the impervious shale beds that are within 3 feet of the surface.

In several small areas, one of which is on the west edge of White Hall, the surface soil is light gray and the subsoil is mottled gray and light yellowish brown down to the bedded shale.

Use and management.—Comly silt loam, eroded phase, although easy to till, has only poor to fair productivity. It has limited suitability for crops because it has only a thin layer of friable soil material over the plastic and impervious layers. About 85 percent of it was used for crops; 7 percent was in forest, 3 percent was in permanent pasture, and the rest was idle at the time of survey. General crops and soybeans were grown. The crops are adversely affected by drought or excessive rainfall. More of this soil should be used for hay or pasture. Oats, soybeans, and mixed clover and timothy return fair yields. Alfalfa will not root deep enough and is poorly suited to this soil. Lime, manure, and complete fertilizers prove profitable for most field crops.

A rotation of moderate length will maintain the productivity of this soil, provided it includes grasses and legumes to supply organic matter and to furnish protection from erosion. For other suggested management see subgroup 5C in table 9.

Comly silt loam, eroded sloping phase (6–12% slopes) (Cr).—Except for stronger slope, this soil is similar to Comly silt loam, eroded phase. Erosion, however, has removed most of the surface soil and part of the subsoil. Shallow gullies are readily formed in clean-tilled fields. Bedded shale is less than 3 feet from the surface in most places.

Use and management.—Yields of such crops as oats, wheat, clover and timothy, and soybeans are fair on this phase, but are 5 to 10 percent below those ordinarily obtained on Comly silt loam, eroded phase, or on Dubois silt loam. On a large part of this eroded sloping phase, clean-tilled crops should be discontinued and replaced by close-growing ones, preferably grass and legumes. This should be done to conserve fertility and to prevent additional gullying. This phase is more droughty than the eroded phase. Its droughtiness is apparent in crop growth on those areas where the organic matter has been lost and the yellow subsurface layer is exposed.

Even for moderate yields of most crops, this soil is deficient in lime, nitrogen, and phosphorus. Legumes, vegetables, and corn will likely need potassium fertilizer. See subgroup 5C in table 9 for suitable management practices.

Crestmore silt loam (3–8% slopes) (Cg).—Weathered pre-Wisconsin till and residuum deposited on limestone ridges is the material from which this soil developed. It is gently sloping well-drained shallow soil—bedrock is encountered in most places within 3 feet of the surface. Erosion has removed about half of the original surface soil, and a few shallow gullies have formed in some of the clean-cultivated areas. The soil is associated with the well-drained deep Washington soils and the imperfectly drained Turbotville soils.

The moderate-brown mellow silt loam surface soil ranges from 4 to 8 inches deep, the depth depending on recent erosion losses. The pale-reddish-brown to strong-brown firm silty clay subsoil rests on massive gray limestone at depths of 24 to 36 inches in most places. Some fragments of gravel and limestone are mixed with the soil material but they do not materially interfere with tillage.

The silt loam is fairly high in organic matter, lime, and other plant nutrients. The subsoil is slightly acid to neutral, permeable to plant roots and moisture, and good in water-holding capacity, considering its shallow depth over bedrock. Runoff is greatest on the more shallow spots.

Use and management.—Practically all of Crestmore silt loam is cleared and used for general crops, soybeans, and alfalfa. Yields are better than those on the shallow phases of the Hagerstown soils.

This is a very desirable upland soil for crops and pasture. It is suited to all the common crops, and especially well suited to alfalfa and other deep-rooted crops. Physical conditions are fairly favorable to maintenance of good tilth, but shallowness to bedrock to some extent inhibits absorption and percolation of water. As a result, surface runoff and erosion are increased and the surface layer tends to be dry or droughty. Erosion, however, is not a major problem under good management. Fertilization is of great importance. Most crops need phosphorus and potassium. Nitrogen fertilizer is a general requirement if nitrogen is not supplied by legumes. Small applications of lime may benefit legumes and grasses. Suitable management practices are shown under subgroup 3A in table 7.

Crestmore silt loam, eroded hilly phase (15–30% slopes) (Ch).—This phase differs from Crestmore silt loam in having greater slope and erosion. Owing to more rugged relief and more advanced erosion, the soil is less suitable for crops. In many places erosion is severe. Practically all the surface soil has been lost, and gullies are

common. Severely eroded and gullied areas are shown on the map by symbols. Several small areas not appreciably eroded have been included with this phase.

Use and management.—Approximately 85 percent of Crestmore silt loam, eroded hilly phase, was used for corn, wheat, mixed hay, and alfalfa at the time of survey. The rest was in forest and pasture grasses. Yields, because of greater erosion and lower organic-matter content, are about 25 percent lower than those obtained on Crestmore silt loam. Crop adaptations are more limited, and legumes and grasses must be used more of the time if the soil is to be held in place. Also, the workability of this soil is less favorable and prevention of erosion is more difficult.

Among the soils of the hilly areas, this soil is considered one of the most productive of grasses and legumes. It is probably best used for hay or pasture because it has strong slopes and absorbs water moderately slowly. Lime and phosphorus are the principal treatments needed for pasture. Some nitrogen and potassium or manure are also beneficial in establishing pastures. See subgroup 8A in table 12 for further information on management practices.

Crestmore silt loam, eroded sloping phase (8-15% slopes) (Ck).—The slope range and moderate erosion of this phase differentiate it from the Crestmore silt loam. In addition, it has slightly thinner surface soil, more gullies, and less organic matter. Its tilth is slightly inferior to that of Crestmore silt loam, and in some small patches its reddish-brown subsoil is exposed. In thickness of the subsoil and in depth of the soil material over limestone, this phase is practically identical to Crestmore silt loam. Several small areas not appreciably eroded have been included with this phase in mapping.

Use and management.—At the time of survey about 90 percent of this soil was used for crops, 5 percent was in forest, and 5 percent was in pasture grasses. Crop yields are about 5 to 10 percent lower than on Crestmore silt loam and more care is necessary in managing this phase. Legumes should occupy a substantial part of this phase if it is to be conserved.

Under a high level of management, this soil is moderately well suited to crops. Rotations should be long and consist largely of close-growing crops, including grasses and deep-rooted legumes. This soil is apparently relatively high in some nutrients, as potassium, but needs nitrogen and organic matter to replace that lost through accelerated erosion. Erosion has impaired the physical condition of the soil. Extra effort should be made to build up the supply of organic matter. The soil is deficient in phosphorus for all crops. Some crops will need lime if they are to produce high yields. See subgroup 3A in table 7 for management practices suitable for this soil.

Dewart gravelly silt loam (3-12% slopes) (Da).—This deep soil developed on weathered glacial till that came largely from sandstone, shale, and quartzite of pre-Wisconsin age. Practically all of the soil occurs in the upper three-fifths of the area, where it occupies undulating to moderately rolling tracts in low valleys.

This gravelly soil has good drainage in both the surface soil and subsoil. From one-half to three-fourths of the original surface layer has been eroded from most areas, and gullies readily occur where clean-tilled crops are grown. Associated with this soil are those having

similar parent materials—the imperfectly drained Warrior and Alvira soils and the poorly drained Shelmadine.

The surface soil consists of 6 to 8 inches of light-brown friable gravelly loam to gravelly silt loam. In wooded areas the topmost inch of it is stained almost black with very acid organic matter. Under the surface soil is a layer of yellowish-brown friable gravelly silt loam that extends to a depth of 15 inches. Next in profile is the lower subsoil, a reddish-brown friable gritty clay loam with a moderately developed subangular blocky structure. At depths ranging from 36 to 40 inches this lower subsoil grades into weathered moderate-brown to yellowish-red till, which is moderately compact.

Field tests indicate that this soil is very strongly to extremely acid where no lime has been applied.

Use and management.—At the time of survey about 90 percent of Dewart gravelly silt loam had been cleared and was being used largely for crops. Approximately 2 percent was in pasture, 5 percent in forest, and 3 percent in areas left idle. Corn, oats, clover, soybeans, potatoes, and tomatoes are better adapted than wheat, pasture, or very shallow rooted crops. Alfalfa does well if lime and other needed nutrients are used liberally. The lower subsoil and parent material are easily penetrated by deep roots, air, and moisture. Fruit trees therefore are well suited, provided air drainage is adequate.

Tilth conditions are very good because of favorable soil texture. Erosion control is not difficult but should be considered in the utilization of this soil. The soil was only moderately productive under the management practiced when this survey was made but it is responsive to better management practices. Lime, nitrogen, phosphorus and potassium all must be supplied to get high yields of most crops. See subgroup 1B in table 5 for other suitable management practices.

Dewart gravelly silt loam, eroded rolling phase (12–20% slopes) (Db).—Although it occurs in close association with the Dewart gravelly silt loam and is similar in profile, this phase occupies stronger relief. Also, in cleared areas its surface soil is generally thinner and gullies are more frequent. In many places the upper subsoil has been exposed, and the organic-matter content of the surface soil that remains is very low. Areas of this eroded soil are well scattered in valleys in the northern and central parts of the counties.

Use and management.—At the time of survey about 85 percent of this soil was in crops, less than 5 percent was in pasture grasses, and 10 percent was idle. The cultivated areas are used to produce the various kinds of crops grown in the county; yields are about 5 to 10 percent below those on Dewart gravelly silt loam.

Close-growing crops should be favored, and the general practice of including 2 years of hay in the rotation instead of 1 year should be followed. Alfalfa should and could be grown on this soil to greater extent. Shallow-rooted pasture grasses are not especially well adapted to this porous soil, but good stands can be obtained by applying the necessary soil amendments. Lime, phosphorus, and potassium are needed for maintaining good yields. The nitrogen and humus supplies also need to be replenished if high yields are to be obtained consistently. Suitable management practices for this soil will be found in subgroup 2B of table 6.

Dewart sandy loam, eroded phase (4-10% slopes) (Dc).—In most places more than half of the original surface layer has been eroded from this soil and occasional shallow gullies have formed.

The 6- to 8-inch surface soil, a brown loose sandy loam to loam, is underlain by reddish-brown friable sandy clay that extends to a depth of 30 inches. The pre-Wisconsin till from which this soil was derived is friable but firm yellowish-brown gritty loam. Some rounded and angular sandstone and shale fragments are mixed with the surface soil and underlying layers.

This soil, like Dewart silt loam, is very strongly to extremely acid throughout, except where lime has been used to correct the acidity of the upper layers. Both the organic-matter content and water-holding capacity of this eroded phase are low; nevertheless, most crops, especially deep rooted ones, return good yields. The underlying glacial till allows good underdrainage and is readily penetrated by roots and air.

Use and management.—Practically all of this soil has been cleared and is being used for general crops, tomatoes, and potatoes. It affords locations for early planting of truck crops and is well suited to them. Pasture grasses, wheat, and timothy do better on heavier soils. Crops yield about 10 percent less than on Dewart silt loam and Dewart gravelly silt loam.

This soil is suited to cropping, but proper use of crop rotations and fertilizer is necessary to obtain high yields. Lime and all the major fertilizing elements—nitrogen, phosphorus, and potassium—are needed to get high yields. This soil responds to these amendments, but their effect is not so lasting as on silty soils of the Crestmore and Washington series. See management subgroup 1B in table 5 for practices suitable for this soil.

Dewart silt loam (3-12% slopes) (Dc).—Like Dewart gravelly silt loam, this soil is restricted to valleys in the northern central parts of the area where pre-Wisconsin till has been deposited. It has a small total acreage. The smaller content of rounded and angular fragments of sandstone and shale in the upper layers of this soil differentiate it from Dewart gravelly silt loam; otherwise the two are similar. Erosion is moderate on most of the cleared areas.

Use and management.—The same crops are grown as on Dewart gravelly silt loam. Yields are practically the same, and requirements for maintaining or increasing them are similar. See management subgroup 1B in table 5 for suggested management practices.

Dubois silt loam (2-7% slopes) (De).—This poorly drained soil occurs in valleys in the areas underlain by thin-bedded black shale. It has developed from strongly acid silt and clay deposited in lakes during pre-Wisconsin time. It differs from Dubois silt loam, mapped in Dubois County, Ind., in being underlain by shale at depths ranging from 5 to 8 feet. The Dubois soil in Indiana is underlain by lacustrine silts and clays that ordinarily extend to depths of 40 to 50 feet or more, and are very distinctly slack-water deposits of Illinoian age.

The 6- to 8-inch surface soil is grayish-brown friable silt loam. The upper subsoil, extending to depths of 15 to 18 inches, is yellowish-brown friable silty clay loam. It is underlain by a mottled yellowish-brown and gray slightly plastic dense silty clay. In this

clay the proportion of gray increases with depth, but the degree of oxidation decreases. In a few places partially weathered black or dull grayish-brown thin shale is encountered at 30 or 36 inches, but in most places the underlying shale is at depths of 5 to 8 feet.

The soil is strongly to very strongly acid in its virgin state. Although surface drainage is adequate, the dense lower subsoil and substratum retard internal drainage.

Use and management.—At the time of survey about 75 percent of Dubois silt loam was used for general crops, soybeans and buckwheat; 5 percent was used for permanent pasture; 10 percent had never been cleared; and about 10 percent was idle. Oats, buckwheat, soybeans, mixed hay, and pasture are better adapted than corn, alfalfa, fruit, and vegetables. It is a late soil for corn and vegetables, and its subsoil is too impervious for deep-rooted plants to penetrate. The soil varies somewhat in productivity, depending to some degree on erosion, which is moderate in most places, and on the moisture conditions, which are influenced by internal drainage. Average conditions of fertility and productivity are similar to those of Alvira silt loam, although this soil is more difficult to drain than the Alvira soil. Close-growing plants should be used to a greater extent on the moderately eroded areas.

Adequate quantities of lime and complete fertilizer are needed to maintain yields. Mixed grasses and legumes should be included in the crop rotation to supply a large part of the nitrogen needed, and to help maintain the physical condition of the soil. Suitable management practices for this soil will be found under subgroup 5C in table 9.

Dunning silty clay loam (0-3% slopes) (Dr).—Nearly all of this dark very poorly drained soil of the flood plains is subject to overflow and to seepage water from higher lying soils. It is associated with the Melvin and Lindsides soils and has developed from similar parent materials. Most of it occurs on the bottom lands along Chillisquaque Creek; several areas occur in depressions along the West Branch of the Susquehanna River.

The surface soil is dark gray to nearly black. Its texture varies between silt loam and silty clay loam, and in most places it has a crumb structure because of the high content of organic matter. At depths of 8 to 12 inches the soil material is lighter in color and somewhat plastic. This lighter-colored material grades into dull-gray or bluish-gray stiff tenacious silty clay or clay, which when partly dry separates into angular fragments along cleavage planes. Some dull-brown rust stains and yellow mottlings are present in many places. The color of the subsoil indicates the saturation and consequent lack of oxidation that prevails most of the time.

Use and management.—At the time of survey an estimated 50 percent of Dunning silty clay loam was in pasture consisting largely of coarse grasses, timothy, and redtop. Some bluegrass and white clover thrived on slightly elevated areas. Only about 20 percent was used for crops, mainly corn and hay; 15 percent was in forest; and 15 percent was idle or too wet for pasture grasses. The part used for crops is either slightly better drained than typical or has been improved by open ditches. Yields of all crops are normally low.

This soil is well supplied with most plant nutrients. Where it can be drained adequately, it is highly productive of corn and legumes. Tile drains should be used wherever suitable outlets can be provided,

so that the soil can be uniformly drained. Lime is not required, but additions of phosphorus and potash would prove beneficial. Wheat, red clover, and soybeans could be included in the cropping system if protection from excess water were provided. For suitable management practices see group 7 in table 11.

Elkinsville silt loam (0-5% slopes) (E_A).—Well-drained positions on terraces along many of the smaller streams are occupied by this soil. It is not subject to overflow, as most of it lies 10 to 25 feet above the stream beds. The parent materials are thought to have been washed mainly from pre-Wisconsin till derived principally from sandstone and shale but influenced somewhat by limestone. The soil is associated with the imperfectly drained Pekin and the poorly drained Bartle soils developed from similar materials. Included with this soil are gradational areas between it and the associated soils, as well as soils having minor variations in texture and color.

The upper 6- to 8-inch layer is a pale-brown porous friable loam to silt loam. The subsoil is light yellowish-brown friable silt loam to silty clay loam. The parent material, usually beginning below 30 inches, is light yellowish-brown friable silt loam or heavy loam. Rounded pieces of sandstone and shale are scattered throughout the soil, but they do not comprise more than 20 percent of the total material, and in most places make up less than 10 percent.

This soil contains a moderate amount of organic matter and other plant nutrients and is strongly acid throughout. The fine-textured subsoil is capable of holding a good supply of moisture, yet it is readily permeable to air, plant roots, and water.

Use and management.—Practically all of Elkinsville silt loam is used for general crops, alfalfa, and vegetables. It is well suited to all crops and is very responsive to good management, including use of fertilizers and other soil amendments. Potatoes and tomatoes do especially well.

Because of its texture and surface relief, the soil is easy to till. The rate of runoff is not rapid enough to wash the soil badly, and erosion, which is only slight in most places, is readily controlled. The soil is suited to moderately intensive use. Probably its productivity can be maintained by using a rotation that keeps the soil in row crops about half the time. Lime and complete fertilizer are necessary for high yields of all crops. Where row crops are grown frequently, the organic-matter supply will decrease unless green-manure crops and legumes are grown periodically. See subgroup 1B in table 5 for additional management suggestions.

Elliber cherty silt loam (4-12% slopes) (E_B).—This soil occurs on the slopes and tops of cherty ridges in the limestone sections; it has developed from material residual from cherty limestone.

In forested areas the first layer, about 8 inches thick, consists of a thin mat of roots and leafmold over weak-yellow loose silt loam. This silt loam grades into weak- to dusky-yellow porous silt loam that rests at a depth of about 30 inches on chert fragments ranging from 3 to 6 inches in width and thickness. These chert fragments are mixed with the subsoil material and comprise from 30 to 75 percent of the total material. The chert makes the soil mass porous and open, interferes with tillage to some extent, and reduces the water-holding ca-

capacity slightly. The chert serves as a mulch on the surface, however, and keeps the upper layers from drying rapidly.

Field observations and experimental investigations indicate that this soil is low in all plant nutrients. It is very strongly acid throughout.

Use and management.—More than 50 percent of Elliber cherty silt loam was in forest at the time of survey, and some of the cleared areas had been abandoned. This is evidence of its poor workability, low fertility, and unsuitability to many crops. Nevertheless, some deep-rooted crops, once they have obtained a foothold in the cherty material, return fairly good yields. Corn, red clover, and fruit trees are best suited. Small grains, pasture, and soybeans are not especially adapted to such a porous soil.

The soil responds to good management, including frequent use of lime, manure, and phosphatic fertilizers. Additional nitrogen can be supplied through increased production of legumes. Where it is used for vegetables or fruit trees, potassium should be included in the fertilizer. Apples and peaches do remarkably well on this type of soil, as has been proved in southern Pennsylvania and in Maryland and West Virginia. Stands of alfalfa will survive more than 2 years, but mowing is a problem because of the many chert fragments.

Some loss of soil by runoff is evident on this cherty silt loam. Although the chert fragments tend to check erosion, hard rains will carry the soil material down the slopes unless a vegetative cover is maintained most of the time or a good root structure prevails.

This soil can be maintained with a rotation of moderate length, provided it is one that includes a legume and it is adequately fertilized. See subgroup 1A in table 5 for suitable rotations and other management practices.

Elliber cherty silt loam, hill phase (20–40% slopes) (Ec).—The narrow strips of this soil occupy simple slopes on the sides of low cherty limestone ridges. Areas that have been cleared have lost slightly more surface soil and organic matter through erosion than have cleared areas of Elliber cherty silt loam, and a few more gullies occur. From one-fourth to three-fourths of the original surface layer has been removed from the cleared areas. Erosion is less, however, than on other soils in these counties having similar slopes. The numerous chert fragments and porosity of the soil material check erosion to some extent.

Use and management.—Probably more than 50 percent of this soil was in forest at the time of survey; most of the rest was used for crops, principally corn and mixed hay. Alfalfa, wheat, and oats are grown to some extent. Yields are 20 to 25 percent below those obtained on Elliber cherty silt loam, which has a milder relief.

Loss of part of its surface soil, stronger slopes, increased susceptibility to erosion, and less favorable workability make this soil less suitable for crops than Elliber cherty silt loam. It is moderately deficient in all plant nutrients—lime, nitrogen, phosphorus, and potassium. For suitable management practices see subgroup 8A in table 12.

Elliber cherty silt loam, rolling phase (12–20% slopes) (Ed).—This phase occupies stronger slopes on the sides of cherty ridges, but except for slope is similar to Elliber cherty silt loam. Because

of the stronger relief, runoff is greater and accelerated erosion has removed one-fourth to three-fourths of the original surface layer from cleared areas. Gullies form in unprotected areas during heavy rains. In some places the soil is exceedingly cherty and difficult to till. In these places many plant seedlings that lie between or on chert fragments that have been washed almost free of soil die from lack of moisture. The wooded areas are generally more cherty than the cleared ones.

Use and management.—About 50 percent of this soil was in forest when this survey was made; the rest was used for general crops, soybeans, and alfalfa. Probably this soil is physically best suited to hay or pasture. It is not especially productive of these, for it is low in all plant nutrients and highly susceptible to erosion because of its strong slopes. Lime, phosphorus, and potassium are needed to keep yields at a fair level. Suitable management practices are given under subgroup 2A in table 6.

Fleetwood channery loam, shallow phase (5–12% slopes) (F_A).—The profile of this soil resembles that of Fleetwood stony loam, but the quantity and size of the shale, sandstone, and quartzite fragments in the surface soil and subsoil and the depth to bedrock differ in the two soils. In this channery loam the rock fragments are less numerous and somewhat smaller, ranging up to about 3 or 4 inches wide and one inch thick. The soil is shallower than Fleetwood stony loam; its depth to bedrock is about 15 to 18 inches. Most of it occurs in the mountains between Shamokin and Mount Carmel, in the southeastern part of Northumberland County.

Use and management.—Like the other Fleetwood soils, this one is inherently infertile and best used for timber. Because of its shallowness it is inclined to be droughty. This soil is classed among those not suitable for cultivation (see group 9 in table 13).

Fleetwood stony loam (12–20% slopes) (F_B).—This is one of the more extensive mountain soils. It has developed on pre-Wisconsin till derived from quartzitic material. Most of it occurs on the broad mountains in the vicinity of Shamokin and Mount Carmel.

The surface soil, extending to depths of 6 to 8 inches, is yellowish-brown to grayish-brown friable stony loam. Below it is a subsoil of yellow to yellowish-brown friable but moderately firm sandy clay or clay loam that extends to depths of 30 to 36 inches. The substratum is light yellowish-brown glacial till containing many fragments of shale, quartzite, and sandstone.

This stony loam is extremely acid throughout and apparently too droughty for shallow-rooted plants. The coal grit and coal chips mixed with the soil in places are also detrimental to root development and plant growth.

Use and management.—At the time of survey all except about 100 acres had been left under a protective forest cover. Forest is the use to which the soil is best suited. Chestnut, red, and scarlet oaks dominate in the timbered areas. The patches that had been cleared at one time for crops were subsequently abandoned. If other conditions were favorable for agriculture, the quartzite stones and fragments of shale could be picked up, but the low inherent fertility of the soil and low response to fertilizer do not warrant this labor. This soil is in management group 9 of table 13.

Fleetwood stony loam, gently rolling phase (5-12% slopes) (Fc).—In texture, structure, consistence, acidity, and amount of plant nutrients, this soil is similar to Fleetwood stony loam. This soil, however, occupies areas that are gently rolling. All of it is in forest, to which it is best suited. See group 9 in table 13 for suggested management.

Fleetwood stony loam, hilly phase (20-35% slopes) (Fd).—This hilly phase has essentially the same profile characteristics as Fleetwood stony loam, but stones are more numerous and larger and slopes are greater. It is therefore less valuable for forestry. Areas occur near Shamokin and Mount Carmel on the broad mountain slopes. All this soil is in forest, and should remain in that use. This soil is in management group 9 of table 13.

Fleetwood stony loam, shallow phase (12-25% slopes) (Fe).—This phase differs from the Fleetwood stony loam in being shallower to bedrock and having a greater quantity of stones in its upper layers. In most places a mass of loose and tight gray sandstone and quartzite shale rocks is encountered below 15 inches. Bare rock is exposed in some places. The soil occurs only in the southeastern part of Northumberland County. It is closely associated with Fleetwood stony loam, but most of it occupies steeper relief. Small patches of deep soil too small to be outlined on the map occur in places.

Use and management.—All of Fleetwood stony loam, shallow phase, is in forest, its best use. Tree growth is slow, however, since the inherent fertility and water-supplying capacity of the soil are very low. See group 9 of table 13 for suitable management practices.

Ginat sandy loam (0-3% slopes) (Ga).—Most of this soil occurs on the terraces along the West Branch of the Susquehanna River. It has developed from the same kind of materials as Ginat silt loam. It is associated with the Sciotoville and Wheeling soils but occupies more level positions that remain wet a large part of the year. The relief is nearly level to slightly depressed.

The 8- to 10-inch surface soil is a gray sandy loam to loam with some yellow and brown splotches. In some places this material is darkened considerably by a liberal supply of organic matter. The subsoil is predominantly gray sticky but friable sandy clay splotched with yellowish brown and yellow. The compactness of this material in some places is partly the cause of the poor drainage. Mottled gray, brown, and yellow slightly compact loam or sandy loam occurs below 30 inches.

Where no lime is used, the soil is very strongly acid throughout. It has a moderate amount of organic matter but is highly leached and inherently low in other plant nutrients.

Use and management.—When this survey was made, about 55 percent of Ginat sandy loam was used for crops, 10 percent for pasture, and 20 percent for forest. The rest was idle. Crop adaptations are narrow, and crop yields are low. Oats and timothy are fairly well suited. Corn, soybeans, and alsike clover do better than wheat, red clover, and vegetables. Red clover yields about one-third as much as on the well-drained soils of equal inherent fertility. Alfalfa will not thrive on this soil and probably would be poorly suited even if the soil was drained. Pasture grasses do fairly well, although the soil is lighter textured than is desirable for pasture.

The ground water table in this poorly drained soil fluctuates considerably. The surface soil frequently changes from saturated to comparatively dry. Roots and air normally do not reach much below 10 inches, and in abnormally wet years are restricted to the surface layer. Tilth is very good after excess water is gone, but the soil is late for spring planting. Deep drainage ditches or tile drains would increase suitability for crops and provide a greater depth of unsaturated soil for root penetration. Applications of lime, manure, phosphorus, and potassium are essential, but best results are attained only where adequate artificial drainage is provided. See subgroup 5C in table 9 for suitable management practices.

Ginat silt loam (0-3% slopes) (G_B).—This poorly drained soil occurs on nearly level terraces. It has developed from medium- to heavy-textured materials that in most places are underlain by gravel at depths of 3 to 5 feet. Associated with it are the imperfectly drained Sciotoville and the well-drained Wheeling soils.

The 8- to 10-inch surface soil is gray friable silt loam, splotched with yellow and brown. This is underlain by mottled gray, yellow, and brown plastic and somewhat compact silty clay loam. The substratum, which begins at a depth of about 30 inches, is mottled gray, yellow, and brown fine sandy clay or silt loam. At depths of 5 to 6 feet this mottled material is underlain by sandy deposits.

The content of organic matter is moderate, but supplies of other plant nutrients are low. In its natural state the soil is very strongly to extremely acid throughout. Drainage is slow because of the heavy subsoil and lack of surface relief.

Use and management.—At the time of survey an estimated 50 percent of Ginat silt loam was used for crops, 30 to 35 percent was in forest, 10 to 15 percent was in pasture, and a few patches were idle. The adaptability of the soil to crops is limited by drainage conditions but is similar to that of Ginat sandy loam. Seepage from higher lying soils makes this soil more difficult to drain adequately than Ginat sandy loam. Nevertheless, grasses do slightly better on it. Corn, soybeans, and buckwheat return fair to low yields. This silt loam is somewhat similar to Bartle silt loam in drainage, crop adaptation, and relief, although somewhat lower in inherent fertility. Recommendations for that soil are applicable. Suitable management practices are given under subgroup 5C in table 9.

Hagerstown silt loam, eroded hill shallow phase (15-40% slopes) (H_A).—Steeper slopes and greater loss through erosion differentiate this soil from Hagerstown silt loam, eroded shallow phase. Most cleared areas have lost one-half to three-fourths of the surface soil. In a few areas all of the surface soil and part of the subsoil have washed down the slopes. These more severely eroded areas are shown on the map by symbols.

Use and management.—At the time of survey probably 50 percent of this soil was used for crops, principally corn, wheat, mixed clover and timothy, and alfalfa. About 10 percent was in pasture, 25 to 30 percent was in forest, and 10 to 15 percent was idle. Yields are expected to be about 25 percent lower on this soil than on Hagerstown silt loam, eroded shallow phase, which is on the milder slopes.

This soil is considered well suited to pasture and rather poorly suited to field crops that require tillage. Among the chief factors limiting suitability are shallowness, with resulting low water-holding capacity; hilliness; and susceptibility to erosion. A firm subsoil and high content of lime are partly responsible for the suitability for grasses and alfalfa or other legumes. Grasses and legumes require phosphate fertilizer to produce high yields and they may need some potash. Management practices for this soil are suggested under subgroup 8A in table 12.

Hagerstown silt loam, eroded shallow phase (3–8% slopes) (H_B).—This soil has developed on shallow material residual from underlying limestone. In most places moderate erosion has occurred since cultivation began. One-fourth to three-fourths of the surface soil has been lost, and a few gullies occur in unprotected spots. Surface soil and subsoil drainage are both very good.

The moderate-brown mellow silt loam surface soil is 2 to 8 inches deep, the depth depending on the losses resulting from recent sheet erosion. The subsoil, extending to depths of 15 to 24 inches, is a weak reddish-brown to strong-brown firm and somewhat brittle heavy silty clay to clay. This layer breaks into angular nutlike aggregates $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter. Underlying the subsoil is hard gray Helderberg limestone.

The soil material is only slightly acid in most places. Applications of lime are seldom needed. The heavy subsoil is firm, but permeable to roots, air, and moisture, and has good water-holding capacity. Shallowness over bedrock limits the water-holding capacity, however, and increases runoff. The workability varies according to degree of erosion and stoniness. In only a few places, however, are outcropping stones and limestone rocks numerous enough to interfere with cultivation. These areas are shown on the map by symbols.

Use and management.—At the time of survey about 90 percent of this soil was used for crops; 5 to 8 percent was in permanent pasture; and the rest supported small patches of woods. The natural adaptation of the soil and its problems of management are about the same as for the Washington soils. The high content of lime and other plant nutrients give this eroded shallow soil productivity superior to that of other shallow soils in the area.

The soil is fairly good for most crops; it is especially well suited to legumes, grasses, and small grains. Conditions are fairly good for maintenance of tilth. Slow permeability of the subsoil handicaps use for vegetables, fruits, and corn, but this is to some extent offset by the fairly high water-holding capacity. Phosphate, and probably potash, is necessary for high yields of legumes. Nonlegume crops and grasses will be benefited by nitrogen and phosphate fertilizer, and possibly by potash. Suitable management practices for this soil are listed under subgroup 3A in table 7.

Hagerstown silt loam, eroded sloping shallow phase (8–15% slopes) (H_C).—This phase occurs on the sides of limestone ridges. It is generally similar to the eroded shallow phase of Hagerstown silt loam except in having greater relief and somewhat more advanced erosion in the cleared areas. From one-half to all of the original surface soil has been removed, and in places part of the subsoil has washed down the slope.

Use and management.—About 65 or 70 percent of this shallow phase was in crops when this survey was made. From 20 to 25 percent was in forest, and the rest was largely seeded to permanent pasture grasses. Owing to a greater loss of organic matter and surface soil and the increased runoff, yields are 10 to 15 percent below those ordinarily obtained on the less sloping eroded shallow phase of Hagerstown silt loam.

When crops are grown, it is advisable, where consistent with good farm management, to restrict the use of this soil largely to small grains, grasses, legumes, and other close-growing crops. Alfalfa, red clover, and Ladino clover are especially well suited. These crops protect the soil from erosion and supply additional nitrogen to replace that lost in runoff water. See subgroup 3A in table 7 for suitable management practices.

Hartleton channery silt loam (3–12% slopes) (Hd).—Belts of this well-drained soil (pl. 2, *B*) running northeast by southwest occur on high ridges or smooth lower mountain slopes. The soil has developed on weathered shallow pre-Wisconsin till and residuum derived principally from acid gray sandstone, shale, and quartzite. It occurs in association with soils developed on similar parent materials—the well drained deep Allenwood and the imperfectly drained Watson soils.

To depths of 6 to 8 inches, the soil is pale-brown friable silt loam containing many angular and subangular shale fragments up to 3 or 4 inches wide and 1 inch or so thick. This material is underlain to a depth of 14 inches by pale-yellow to light yellowish-brown friable highly leached silt loam. The subsoil is brown or yellowish-brown friable clay loam containing numerous shale fragments. Gray to grayish-brown shale is encountered 24 to 40 inches below the surface. The shale is often loose and broken to a depth of 5 or 6 feet, and some soil material has formed in the interstices. The gravel and channers in the upper layers interfere with cultivation to a small extent, but tend to render the soil more porous and check erosion. In cleared areas one-fourth to one-half of the original surface soil has washed down the slopes.

This soil is very strongly acid in all horizons. It is moderately low in organic matter and plant nutrients but is well aerated and easy to till.

Use and management.—When this survey was made, over half of Hartleton channery silt loam had been cleared and was being used for crops. The rest was partly in pasture and partly idle. All crops return fair to good yields. Potatoes and tomatoes do better than on some of the more fertile soils higher in lime. Areas of this soil on high ridges are well adapted to apples and peaches. The commercial fruit orchards in the two counties are located largely on this and the Weikert soils.

This soil is capable of producing all crops common in the area, including the more exacting ones such as alfalfa. It is moderately low in natural fertility, which necessitates applications of complete fertilizer and lime to get high yields. Good tilth is easily maintained. Control of erosion is not a serious problem, though the soil is moderately susceptible to erosion. Management practices are recommended for this soil under subgroup 3B in table 7.

Hartleton channery silt loam, eroded hilly phase (20–40% slopes) (H_E).—Nearly all of this soil is cleared. Where it has been cleared for a long time, practically all of the original surface soil and part of the subsoil have been lost. Runoff is rapid, and both shallow and deep gullies are characteristic of most areas. Except for degree of slope, this soil is similar to Hartleton channery silt loam.

Use and management.—Mixed hay, corn, and wheat are largely grown on this soil. Probably 10 percent of it was abandoned at the time of survey. It is not well suited to tilled crops, as it is highly susceptible to further erosion. On most farms it is probably best used for pasture. Management practices recommended are those under subgroup 8B in table 12.

Hartleton channery silt loam, eroded phase (3–12% slopes) (H_F).—The subsoil, substratum, and most soil characteristics of this phase are identical to those of Hartleton channery silt loam. This phase differs, however, in having in all fields shallow gullies that are mostly more than 100 feet apart but considerably closer in some places. Deep gullies have formed in a few areas. From one-fourth to all of the original surface soil has been lost, and in general the organic-matter content is lower than in Hartleton channery silt loam.

Use and management.—Practically all of this eroded phase has been cleared. Except for several small patches of idle and pasture land, it is used for crops, fruits, and vegetables. Yields are estimated to be somewhat lower than on the less eroded Hartleton channery silt loam. Erosion can be controlled on most of this soil by simple conservation practices, such as strip cropping, contour tillage, sodding of waterways, and proper choice of crop rotations. Ordinarily, a rotation of at least moderate length that includes a deep-rooted legume is desirable. The soil is deficient both in lime and the major fertilizing elements. See subgroup 3B in table 7 for suitable management practices.

Hartleton channery silt loam, eroded rolling phase (12–20% slopes) (H_G).—This phase has stronger slopes than Hartleton channery silt loam. In addition, areas of it are more subject to erosion and have a surface soil slightly thinner, or only 3 to 4 inches thick. Shallow gullies are readily formed during heavy rains.

Use and management.—At the time of survey about three-fourths of this eroded rolling phase had been cleared. Because of its greater runoff and lower organic content, yields on this phase are lower than those on Hartleton channery silt loam. At least 2 years of hay crops should be included in a 4- or 5-year rotation to hold this soil. Lime, manure, and commercial fertilizers are necessary for maintenance of crop yields. Suitable management practices for this soil are given under subgroup 4B in table 8.

Hartleton channery silt loam, hilly phase (20–40% slopes) (H_H).—The profile characteristics of this soil are similar to those of Hartleton channery silt loam, but the surface layer is somewhat thinner. Sheet erosion has removed one-fourth to three-fourths of the original surface soil from cleared areas.

Use and management.—More than 90 percent of this hilly phase was in forest at the time of survey. The rest was used largely for crops, principally corn, wheat, and hay. Much of the soil is too steep for

use of a binder. Yields are low. They depend largely on the amount of rainfall during the growing seasons, the management practices used, and erosion conditions.

The soil is suited to pasture and close-growing crops, but poor for crops requiring tillage. It is somewhat low in plant nutrients, difficult to till, and highly erodible when cleared. Cleared areas are used and managed in about the same way as similar areas of Hartleton channery silt loam. See subgroup 8B in table 12 for suitable management practices.

Holly silt loam (0-3% slopes) (Hk).—Poorly drained areas on the flood plains are occupied by this soil. It has originated from materials washed from uplands underlain by acid shale, sandstone, and quartzite. Associated with it are the well-drained Tioga and imperfectly drained Middlebury soils, which came from similar materials. Most of Holly silt loam is subject to annual overflow. The depth to ground water depends on the stage of the nearby stream. In some places the soil is completely saturated much of the time because of seepage from adjacent slopes as well as its low position.

The 8- to 12-inch surface soil is dark-gray friable silt loam or silty clay loam stained brown and yellow in places. The subsoil is more or less variable in texture and consistence but in most places is gray, splotted with yellow and brown, friable silty clay loam. In several areas the surface soil is almost black and high in organic matter and the subsoil is a bluish-gray heavy clay. This phase is moderately to very strongly acid.

Use and management.—When this survey was made, about 35 percent of Holly silt loam was in pasture; 25 percent was used for crops, mainly corn and hay; 20 percent was in forest; and the rest was idle. Alfalfa, small grains, and vegetable crops do not thrive. Pastures consist of sedges in the wetter places, or timothy, reedtop, orchard grass, and some bluegrass on the higher spots. Some areas are too wet for many of the pasture grasses.

Lime, phosphate, and potash fertilizers, though beneficial, are not generally used. The increased yields hardly pay for the cost of the fertilizer. Poor drainage and susceptibility to overflow limit the response to fertilizer. Digging of open ditches and the deepening of present stream channels would improve some of the soil by providing outlets for runoff of surface water and by lowering of the water table to some extent. This soil is in management group 7 (see table 11).

Huntington sandy loam (0-3% slopes) (Hl).—The low well-drained positions occupied by this soil are on the bottom lands of the Susquehanna River, mostly 8 to 15 feet above the river. The relief is mild except on the river banks. The soil occurs in association with Huntington silt loam and is somewhat like Ashton fine sandy loam, but is more frequently overflowed.

The 10- to 16-inch surface soil is brown porous sandy loam. This overlies a friable moderate-to-strong brown loam to sandy clay subsoil. The substratum is sandy and moderate brown to moderate yellowish brown in color. In a few places considerable gravel is mixed with the soil material; these areas are indicated on the map by gravel symbols. On low places subject to very frequent overflow, the soil is a brown sandy loam to a depth of 36 inches and shows no noticeable change or leaching throughout the profile.

This sandy loam is slightly to medium acid throughout. It is apparently fairly well supplied with most plant nutrients, including nitrogen, organic matter, and lime. It has better moisture properties than its sandy texture would indicate.

Use and management.—At the time of survey about 80 percent of Huntington sandy loam had been cleared and was in crops. Corn, the principal crop, is grown almost continually in some places. Mixed hay alternates with corn in a 2-year rotation in some fields. Some soybeans, wheat, and vegetables are also produced. Fall-sown crops are safe from overflow in only a few places. Applications of phosphorus and potash fertilizer benefit this soil; its inherent supply of lime probably is sufficient for most crops.

The uncleared areas, most of them lower and subject to more frequent inundation, support luxuriant growths of oak, poplar, sycamore, and beech. For suitable management practices see subgroup 6A in table 10.

Huntington silt loam (0-3% slopes) (Hm).—The materials from which this soil originated were washed from soils underlain by limestone as well as sandstone and shale. The soil occurs in association with Huntington sandy loam, Ashton silt loam, and the Lindsides, Melvin, and Dunning soils. Unlike Ashton silt loam, which it closely resembles, Huntington silt loam is subjected to periodic overflow and regularly receives small deposits of materials from overflowing streams. This Huntington soil is therefore younger and slightly more fertile than the Ashton and shows less development into distinct surface, subsurface, and subsoil layers.

The soil in this area is brown mellow silt loam to depths ranging from 10 to 18 inches. This is underlain by moderate yellowish-brown to strong-brown moderately firm silty clay loam. Below 30 to 36 inches the material is somewhat lighter in color and texture and has adequate drainage. Small rounded pieces of gravel are abundant on the surface in several places indicated on the map by the gravel symbol.

This soil ranges from medium acid to neutral but in most places is slightly acid to neutral. It is liberally supplied with essential plant nutrients. The least acid areas are close to the stream bed, where there has been more recent deposition. The soil has characteristics highly favorable to drought resistance without having the susceptibility to wet weather that marks most areas of imperfectly drained soils.

Use and management.—Since its productivity and workability are good, Huntington silt loam is well adapted to many crops. More than 90 percent of it was used annually for crops at the time of survey. The rest supported narrow strips of pasture and forest. The usual field crops are grown, and soybeans, alfalfa, and vegetables. All legumes do well where damage from overflow is negligible. In some low areas corn is grown continually with good returns. Although all this soil is subject to overflow, it is generally inundated only a short time. Flood damage to crops is limited to the lowest parts of the fields.

In places, clover and alfalfa respond to light applications of lime. Additions of phosphorus and potash are also beneficial. Manure usually can be more efficiently used on the soils of the uplands and terraces. Wheat and oats lodge considerably in some places because

of the high content of nitrogen. Addition of potash fertilizer to strengthen the straw would be beneficial where lodging occurs. Although this soil is not fertilized so heavily as soils on the uplands and terraces, yields are as high as on any of the better soils derived from limestone. See subgroup 6A in table 10 for additional information on management.

Kistler shaly silt loam (2–12% slopes) (K_A).—This soil has developed from weathered shallow pre-Wisconsin till and residuum derived principally from dark-gray or black acid shale. Most of it is found in association with the Stephensburg and Comly soils.

The surface soil is a brown to yellowish-brown silt loam containing some small disintegrated shale chips. Moderate yellowish-brown friable heavy silt loam containing many small thin pieces of weathered shale begins at depths of 6 to 8 inches. Below 15 to 20 inches is a brownish mass of thin broken shale with some soil material in the interstices. The depth of the pre-Wisconsin till from which this soil has developed is variable—in places on the crest of ridges it is less than 6 inches, whereas in dips or pockets it is more than 2 feet.

The soil material and weathered disintegrated shale are acid, but in some deep cuts the bedded black shale is neutral or alkaline.

Use and management.—At the time of survey crops were grown on about 65 percent of Kistler shaly silt loam, and permanent pasture on 5 to 10 percent. About 10 to 15 percent had been abandoned, and the rest was in forest.

Because of fine texture and shallowness, this soil is adapted to grasses and shallow-rooted plants. Other crops return fair yields when fertilizer is used liberally, but they are stunted because of limited root development. Erosion is slight to moderate on cleared areas; from one-fourth to three-fourths of the original surface soil has been lost.

Shallowness, susceptibility to erosion, low water-holding capacity, and low fertility make this soil poorly suited to intertilled crops. Probably it is best used for pasture and close-growing crops such as legumes and grasses. The soil needs lime, organic matter, and phosphorus if it is to produce good yields of crops or pasture. Potassium is less likely to be deficient, but it may be needed for special crops or legumes. See subgroup 3B in table 7 for suitable management practices.

Kistler shaly silt loam, eroded hilly phase (20–40% slopes) (K_B).—The principal difference between this soil and Kistler shaly silt loam is its steeper slopes and eroded condition. Accelerated erosion is moderate to severe; only a little of the original surface soil remains. In some places the disintegrated black Marcellus shale is exposed. Shallow gullies are frequent, and deep gullies have cut into the substrata in some of the fields.

Use and management.—When this survey was made, about 35 to 40 percent of the soil was being used for corn and hay crops; 20 to 25 percent was in pasture; and about 40 percent had been abandoned. Part of the abandoned land is gradually growing back to forest. Crop yields are about 30 to 35 percent lower than those on Kistler shaly silt loam, which occurs on milder slopes. Because of its silty texture and shallow depth, this eroded phase is somewhat better suited to pasture than to forest. All of it that is not being reforested should

be used for pasture. Overgrazing should be avoided. Subgroup 8B of table 12 gives suitable management practices for this soil.

Kistler shaly silt loam, eroded phase (2-12% slopes) (Kc).—This phase is separated from the Kistler shaly silt loam because of its degree of erosion. From one-half to all of the original surface soil has been lost, the organic and nitrogen content has been lowered, and tilth has become impaired. Gullies, mostly shallow and ranging from 50 to more than 200 feet apart, occur in all fields. In a few places they have cut through the soil material to the bedded shale and cannot be crossed by heavy farm machinery.

Use and management.—Practically all of Kistler shaly silt loam, eroded phase, had been cleared at the time of survey, and about 80 percent was in crops. From 10 to 15 percent had been abandoned, and 5 or 10 percent was seeded to pasture grasses. Crop yields are about 5 to 10 percent less than on Kistler shaly silt loam, which is less eroded. To control erosion, strip cropping, contour tillage, sodding of waterways, and similar practices should be used where row crops are grown. Owing to the shallowness of this soil, however, more of it should be seeded to grasses and legumes for hay or pasture. For suitable management practices see subgroup 3B in table 7.

Kistler shaly silt loam, eroded rolling phase (12-20% slopes) (Kd).—Practically all of this phase had been cleared at the time of survey. It has been considerably damaged by erosion. It is separated from Kistler shaly silt loam because of its stronger slopes and eroded condition. From one-half to all of the original surface soil has been washed from most of it. Shallow gullies, ranging from 50 to slightly more than 200 feet apart, occur in all fields. A few deep gullies have cut trenches into the substratum.

Use and management.—General crops, soybeans, and alfalfa were being grown on about 80 percent of this soil at the time of survey. About 5 to 10 percent was in pasture, and 10 to 15 percent was idle. Yields range from 10 to 20 percent below those ordinarily obtained on Kistler shaly silt loam, which has milder slopes.

This soil is poorly suited to intertilled crops, for it is shallow, susceptible to erosion, low in water-holding capacity, and low in fertility. It is better suited to pasture or to legume-grass mixtures for hay. For most crops or pasture grasses, it is deficient in lime, nitrogen, and phosphorus. Supplies of potassium are less likely to be deficient. Management practices suitable for this soil will be found under subgroup 4B in table 8.

Kistler shaly silt loam, hilly phase (20-40% slopes) (Ke).—In depth of soil material, content of organic matter and plant nutrients, and other soil characteristics, this phase is practically identical to Kistler shaly silt loam, which is on gentle slopes. Slope is the main difference between the two soils. The soil is entirely in forest. Pines do better than hardwoods on this shallow soil, since they tolerate droughty conditions better.

Use and management.—This soil should not be used for crops. Some of it is capable of producing fair pasture. Lime and phosphate fertilizer would be needed for grass-and-legume pastures. See subgroup 8B in table 12 for suitable management practices.

Kistler shaly silt loam, rolling phase (12–20% slopes) (K_F).—This phase differs from the Kistler shaly silt loam only in having stronger relief. Practically all of the soil is in forest. If it were cleared, yields of crops would probably be 5 to 10 percent below those on Kistler shaly silt loam. Runoff would be greater, and erosion could not be controlled satisfactorily if clean-cultivated crops were grown. Owing to the shallow depth of this rolling phase, most of it probably should remain in forest, or if cleared, limited to pasture grasses and close-growing crops. It is similar to Kistler shaly silt loam, eroded rolling phase, in management requirements. Suitable management practices are listed under subgroup 4B in table 8.

Klinesville gravelly silt loam, eroded hill phase (20–35% slopes) (K_G).—Steeper slopes, a somewhat thinner surface soil, and more frequent occurrence of gullies in cleared areas differentiate this soil from the eroded phase of Klinesville gravelly silt loam, which is on less strong slopes. Otherwise the appearance of the two soils is similar. Only about one-fourth to one-half of the original surface soil of this eroded hill phase is left, and in some places the underlying soil and shale material are exposed.

Use and management.—At the time of survey only about 15 percent of this soil was in forest; whereas about 65 percent was in crops, 15 percent was idle (pl. 2, C), and about 5 percent was in permanent pasture.

This soil is not suited to crops that require tillage; its chief disadvantages for that use are hilliness, shallowness, and high susceptibility to erosion. Nevertheless, it will support fair to good pasture where adequate lime and phosphate are applied. If it is used for crops, only close-growing ones including a high percentage of legumes or grasses should be grown. Management practices for this soil are recommended under subgroup 8B in table 12.

Klinesville gravelly silt loam, eroded phase (12–20% slopes) (K_H).—This rather shallow soil has developed on weathered reddish-brown pre-Wisconsin till and residuum derived principally from acid red shale. It occurs largely in the southwestern part of Northumberland County. Because it has a somewhat thicker surface soil and greater depth to the underlying bedded red shale formations, it is slightly superior to the eroded phase of Klinesville shaly silt loam. The soil mantle, generally about 18 to 24 inches in thickness, contains more foreign rock fragments than that of Klinesville shaly silt loam, eroded phase. The content of rounded sandstone and quartzite fragments in the upper layers is generally more than 20 percent, but is less than 10 percent in a few places.

Use and management.—At the time of survey, general crops—including corn, oats, wheat, mixed hay, soybeans, and alfalfa—were grown on about 85 percent of this soil. Yields are nearly the same or slightly higher than those on Klinesville shaly silt loam, eroded phase. About one-fourth to three-fourths of the original surface soil has been removed by erosion. The management practices needed are chiefly those to prevent erosion and improve the moisture and physical conditions of the soil. These are required if larger yields are to be obtained continuously. Lime, phosphorus, and nitrogen are required for good crop yields, and potash will be needed for legumes. See subgroup 4B in table 8 for suggestions on management.

Klinesville gravelly silt loam, eroded undulating phase (3–12% slopes) (Kκ).—This soil is separated from the undulating phase of Klinesville gravelly silt loam on the basis of erosion only. It is mapped in all fields where gullies occur. Most of the gullies are shallow and more than 100 feet apart, but in a few fields they are considerably more numerous and tillage conditions are less favorable. Its slope range is the same as for the undulating phase, but in many places this eroded phase has a thinner surface soil.

Use and management.—When this survey was made, practically all this soil had been cleared and about 90 percent was in crops. The rest was about equally divided between pasture and abandoned land. Average crop yields are lower than those on the undulating phase of Klinesville gravelly silt loam, but higher than those on the eroded phase of Klinesville gravelly silt loam. Contour tillage, strip cropping, and increased acreage of grasses and legumes are necessary to control erosion. Lime, nitrogen, phosphorus, and possibly potassium are also needed if the soil is to be maintained and produce maximum yields. Management practices are recommended under subgroup 3B of table 7.

Klinesville gravelly silt loam, undulating phase (3–12% slopes) (KL).—This phase occurs on smooth ridges and undulating uplands. Owing to the more level relief, it is less eroded, slightly higher in organic matter, and higher in crop yields than the eroded phases of Klinesville gravelly silt loam and Klinesville shaly silt loam. Problems of conservation and management are less complex.

Use and management.—This soil is well suited to use for crops and pasture, but proper rotation of crops and application of fertilizer are necessary to obtain satisfactory yields. The soil is deficient in lime, nitrogen, and phosphorus and is responsive to these nutrients. The response, however, is not likely to be so great as on the deeper well-drained soils with a higher water-holding capacity. Potash fertilizer is likely needed for most legumes and truck crops. Management practices suitable for this soil will be found under subgroup 3B in table 7.

Klinesville shaly silt loam, eroded hill phase (20–35% slopes) (Kκ).—This phase is slightly thinner than Klinesville shaly silt loam, eroded phase. Also, gullying is more frequent, and slopes are steeper. Otherwise the two soils are fairly similar. Much of this soil should never have been cleared, as is evident in the large amount of idle land (at time of survey 15 to 20 percent of the total area). About 15 percent has remained in forest. The cultivated areas are used mostly for corn and mixed hay.

Use and management.—Probably this soil is best suited to pasture grasses. Among factors limiting suitability are shallowness, which results in low water-holding capacity, hilly slopes, and high susceptibility to erosion. By careful management, some farmers have used this soil for crops a number of years. Yields, however, are generally low. Pasture grasses and legumes need lime and phosphorus; potassium is less likely to be needed. See subgroup 8B in table 12 for suggested management practices.

Klinesville shaly silt loam, eroded phase (12–20% slopes) (KN).—The small tracts of this very shallow soil occur in the red shale

area. The parent material is shallow weathered weak reddish-brown pre-Wisconsin till and residuum derived principally from acid red shale. Most of the soil occurs in the southwestern part of the county in association with the Leck Kill and the Norton soils. Although the thinness of the soil layers probably results largely from scraping by the Jerseyan ice sheet and geological erosion, the loss of one-half to all of the original surface soil from most of the cleared areas was caused by recent accelerated erosion. Shallow gullies quickly form in cultivated fields during heavy rains.

The surface soil, extending to depths of 4 to 6 inches, is dark reddish-brown very strongly acid friable silt loam, 25 to 50 percent of which is small red shale fragments. The material has a purplish cast that is more noticeable in the shale fragments than in the soil, which is darkened by organic matter. Partially weathered acid Mauch Chunk red shale, mixed with some soil material, underlies the surface soil in most places at variable depths. The content of shale increases with depth until bedded shale is encountered, generally at 15 to 20 inches.

Practically all of the shale, as well as the soil material, is strongly acid except where lime has been applied. This soil is inclined to be droughty, and roots have difficulty penetrating the shale formations.

Use and management.—Klinesville shaly silt loam, eroded phase, is used mainly for crops. At the time of survey about 80 to 85 percent of it was in crops, 10 percent in forest, and 5 to 10 percent partly in permanent pasture and partly idle.

It is best used for pasture or grass-legume meadows but can be used for row crops and small grains when recommended conservation practices are employed. Grasses and legumes can be grown fairly successfully, and the soil fertility can be maintained by adequate applications of fertilizer. The soil does not furnish enough lime, nitrogen, and phosphorus for most plants. It is less likely that deficiency in potassium will limit plant growth. Where row crops are grown, strip cropping, contour tillage, and sodding of waterways will aid in controlling erosion. Management practices are recommended for this soil under subgroup 4B in table 8.

Klinesville shaly silt loam, eroded steep phase (35–50% slopes) (Ko).—Steep, almost precipitous, slopes are occupied by this soil, which is similar to Klinesville shaly silt loam, eroded phase, except in slope and in having more red shale and red sandstone in the upper layer and more gullies on the cleared areas.

Use and management.—Approximately 60 percent of this steep eroded soil was in crops at the time of survey, about 15 percent was forested, 15 percent idle, and the rest in permanent pasture. Corn and mixed hay are grown on the steep slopes, which are not only difficult to farm but also return very low yields. This soil should be retired to permanent pasture or reforested, whichever fits best in the management plan. For pastures that include a legume, lime and phosphate fertilizer are necessary. See subgroup 8B in table 12 for suitable management practices.

Klinesville shaly silt loam, eroded undulating phase (3–12% slopes) (Kr).—In internal characteristics, relief, and suitability to crops, this phase is like Klinesville shaly silt loam, eroded phase. It

differs from the eroded phase in having milder slopes. Shallow gullies are in all fields, and only 2 to 4 inches of the original surface soil remains.

Use and management.—At the time of survey practically all of this eroded soil had been cleared. About 90 percent of the land cleared was used for field crops, fruit, and vegetables; approximately 10 percent was partly idle and partly in permanent pasture. Crop yields are higher than on the eroded phase of Klinesville shaly silt loam, as runoff is slower.

Shallow depth and low water-holding capacity make this soil not very desirable for crops. Nevertheless, fair yields can be maintained by following a high level of management. Crop rotations should be long and consist largely of close-growing legumes and grasses. Fertilization is necessary for production of all crops, as the soil is somewhat low in organic matter, lime, and phosphorus. It is less likely to be low in potassium. Strip cropping, contour tillage, and sodding of waterways reduce susceptibility to erosion. Suitable management practices are given under subgroup 3B in table 7.

Klinesville shaly silt loam, undulating phase (3–12% slopes) (Kr).—Owing to more level relief, this soil is less eroded, has a deeper surface soil, and is richer in organic matter than Klinesville shaly silt loam, eroded phase. In other characteristics and underlying materials, the two are similar. Erosion has removed approximately one-fourth to three-fourths of the original surface soil from this undulating phase, but no gullies existed at the time of mapping.

Use and management.—At the time of survey about 75 percent of this soil was in general crops, soybeans, and alfalfa. The rest was largely in forest. Management requirements are similar to those of Klinesville shaly silt loam, eroded undulating phase, but yields should be slightly higher because of less erosion. Suitable management practices for this soil are given in subgroup 3B of table 7.

Klinesville stony loam (5–60% slopes) (Ks).—The brows of hills or short steep slopes are occupied by this soil. The soil mantle is exceptionally thin or entirely absent. Bare red shale or red sandstone formations are exposed on 75 percent of this type. Very small patches of this shallow soil are cleared and included in fields with other soils having greater depth; the rest support a scrubby growth of pine and oak.

Use and management.—Forestry is the most suitable use for this soil. It is in management group 9 of table 13.

Kreamer cherty silt loam, eroded hilly phase (15–25% slopes) (Kr).—Steeper slopes distinguish this soil from Kreamer cherty silt loam, eroded phase. From one-half to nearly all of the original surface layer of this soil has been lost. Gullies occur frequently, and some of the subsoil has been carried away through them. In only a few places, however, could the soil be classed as severely eroded, and these places are shown on the map by symbol.

Use and management.—About 15 percent of this eroded hilly soil was in forest at the time of survey. About 15 percent was in permanent pasture, and most of the rest was in crops. Acre yields are at least 20 or 25 percent below those obtained on the more mildly sloping Kreamer cherty silt loam, eroded phase.

This eroded hilly phase of Kreamer cherty silt loam is best suited to pasture or forest. It is difficult to work and highly susceptible to further damage by erosion because it has moderately strong slopes. If used for crops, it should be limed, heavily fertilized, and seeded to legumes, timothy, or other hay crops. For management suggestions see subgroup 8A in table 12.

Kreamer cherty silt loam, eroded phase (2–8% slopes) (Kv).—This imperfectly drained soil has developed on weathered pre-Wisconsin till derived principally from cherty limestone. It occurs on areas of mild hummocky relief (pl. 3, A) in the valleys adjoining the cherty ridges. Associated with it are the Mertz soils that have developed on similar materials. Erosion is moderate to severe on most of the cleared areas. From one-fourth to three-fourths of the original surface soil has been lost. Shallow gullies are common in poorly managed fields.

In cultivated fields the surface material is 2 to 8 inches of yellowish-brown, friable, and cherty heavy loam to silt loam. The depth of this layer depends on the amount of recent sheet erosion. Next in profile is a pale-yellow to light yellowish-brown friable silt loam to silty clay loam. Then, at depths of 20 to 30 inches, a yellowish-brown slightly compact silty clay loam with splotches of light gray is encountered. This splotched layer is less permeable to water, air, and roots than those above it; consequently, the layers above it quickly become saturated with water during rains. The chert fragments strewn over the surface and mixed with the subsoil and parent material have little effect on runoff or erosion and are not large or numerous enough to interfere with tillage.

This phase is strongly or very strongly acid throughout. It has a moderate amount of plant nutrients and is fairly productive of most of the crops grown in this section of Pennsylvania. Nevertheless, growth of deep-rooted plants such as alfalfa and apple trees is restricted by the compact poorly drained layer in the lower subsoil.

Use and management.—At the time of survey 90 percent of this soil was used for corn, oats, wheat, hay, and soybeans. Less than 5 percent was in forest, and the rest was idle land, pasture, and building or town space.

This soil can be used rather intensively for crops. Rotations, however, must be of moderate length and include a hay crop or legume at least 1 year, and preferably 2 years, to maintain the supply of organic matter and the physical condition of the soil. Winter cover crops should follow all clean-cultivated crops. Sodding of water-courses and strip cropping or terracing may be satisfactory for some areas. Lime and nitrogen, phosphate, and potash fertilizers are required for most crops. Management practices suitable for this soil are given in subgroup 5A of table 9.

Kreamer cherty silt loam, eroded rolling phase (8–15% slopes) (Kv).—Relief and runoff are greater on this soil than on Kreamer cherty silt loam, eroded phase. From one-half to all of the original surface soil has been lost from most areas, and shallow and deep gullies have formed in many places. Several severely eroded areas are shown on the map by symbol.

Use and management.—Owing to greater runoff and the consequent lowering of organic-matter content, crops yield 10 to 15 percent less

than they ordinarily do on Kreamer cherty silt loam, eroded phase, which occupies milder slopes. Elimination of some of the cereal crops and growing hay crops at least 2 or 3 years in the rotation are necessary for the conservation of this soil. Strip cropping, contour tillage, and sodding of watercourses are aids in controlling erosion. Lime and complete fertilizer are necessary to maintain yields of most crops. See subgroup 5A in table 9 for suggested management practices.

Kutztown shaly silt loam, eroded hill phase (20–25% slopes) (Kw).—This phase is distinguished from Kutztown shaly silt loam, eroded phase, by smooth but steep slopes. As a result of its steepness and erodibility, crop yields are lower on this soil than on the gently sloping eroded phase. Crop adaptations are more limited, runoff is greater, workability is less favorable, and conservation is more difficult on this phase.

Use and management.—At the time of survey an estimated 65 to 70 percent of this soil was in general crops, 15 percent in permanent pasture, and nearly 10 percent in land left idle. The rest was forested or was town property.

Permanent pasture that includes a legume (or trees for areas severely eroded) is the best use for this soil. Where small acreages must be tilled, long rotations consisting mostly of close-growing crops and grasses and legumes should be followed. Management practices suitable for this soil are listed under subgroup 8A in table 12.

Kutztown shaly silt loam, eroded phase (12–20% slopes) (Kx).—This well-drained shallow soil occurs on low ridges and slopes; it has developed from weathered pre-Wisconsin till and residuum derived from olive-gray calcareous shale. Associated with it are the well-drained deep Mifflinburg soils that developed from similar materials. Erosion is moderate in most places—from one-fourth to three-fourths of the original surface soil has been removed. A few badly gullied strips (indicated on the map by symbol) have lost practically all of the original surface soil.

In cultivated fields the moist surface soil is brownish-gray shaly silt loam that becomes gray on drying. The material is friable, but from 20 to 50 percent of it is olive-gray shale fragments. The shale does not interfere with cultivation but prevents clodding when the soil is plowed wet. Beginning at depths of 6 to 12 inches is light yellowish-brown friable silty clay loam that contains many soft partly disintegrated shale chips. At depths of 14 to 18 inches this silty clay loam rests on partially weathered bedded shale. The shale is twisted and broken in many places, probably because of frost action during the Wisconsin glaciation; this tends to increase the absorption of water.

The soil layers are slightly acid to neutral; the underlying shale is calcareous or limy in most places. This condition favors the growth of legumes. The soil is well suited to clovers and alfalfa. Surface drainage, aeration, and permeability are good.

Use and management.—At the time of survey approximately 85 percent of Kutztown shaly silt loam, eroded phase, was being used for most of the crops grown in the area. About 5 percent was in pasture grasses; the rest was partly in forest, partly idle, and partly covered by towns.

During extended dry spells crops are damaged more on this soil than on the deeper well-drained soils. Tilth conditions are good, however, and the soil responds fairly well to good management, including application of fertilizer. It is well suited to pasture and legume crops. Lime generally is not needed. The main deficiencies are nitrogen and phosphorus; potassium is less likely to be deficient. For suitable management practices see subgroup 4A in table 8.

Kutztown shaly silt loam, eroded sloping phase (8–12% slopes) (K_Y).—Relief is milder for this phase than for Kutztown shaly silt loam, eroded phase; consequently, runoff is slower and erosion is slightly less destructive. From one-fourth to three-fourths of the original surface soil has been lost. Shallow gullies, usually more than 100 feet apart, have formed in all fields but can be crossed by most types of farm machinery.

Use and management.—At the time of survey field crops were grown on about 70 percent of this eroded sloping phase, and pasture was on 15 percent. The rest was in forest or idle. Crop yields average about 5 percent higher than on Kutztown shaly silt loam, eroded phase. A high percentage of this sloping phase should be used for legumes and pasture grasses. Growing of grass-legume mixtures, particularly mixtures of grasses with alfalfa, aids in controlling erosion. Alfalfa grown alone seems to give rather poor erosion control on shallow soils.

This soil is deficient in phosphorus for maximum yields of most crops and pasture plants; it may be somewhat deficient in potassium. Suggested management practices are given under subgroup 4A in table 8.

Kutztown shaly silt loam, gently sloping phase (4–8% slopes) (K_Z).—This phase occupies ridges in association with the other Kutztown and the Mifflinburg soils. Because it is more level, it is less eroded than Kutztown shaly silt loam, eroded phase, has a deeper surface soil, and is richer in organic matter. Such differences in the two soils are slight, however, and the lower horizons are similar.

Use and management.—The percentage of this soil used for row crops, pasture, and forest is about the same as for the eroded sloping phase of Kutztown shaly silt loam. This soil is on milder slopes than the eroded phase, however, and has an advantage both in crop yields and in ease of management and conservation. Erosion probably can be controlled with the rotation now followed if contour tillage and strip cropping are practiced and necessary soil treatments are added. See subgroup 3A in table 7 for suitable management practices.

Lakin loamy fine sand (3–12% slopes) (L_A).—This soil occurs on the stream terraces or adjacent to them. It has developed from materials moved and rolled by wind action into hummocks and knolls. Most of the materials were blown from the Susquehanna River flood plains. The hummocks and knolls are not sharp; surface relief is mild enough for use of all types of farm machinery.

The 6- to 10-inch surface soil, a light yellowish-brown porous loamy fine sand, is underlain by yellowish-brown fine sandy loam that continues to depths of 24 to 30 inches. Yellowish-gray to gray loamy fine sand underlies this fine sandy loam and extends to depths of 5 to 20 feet.

All horizons of the soil are strongly to very strongly acid. The organic content has been built up considerably by the addition of

manure and cover crops, and plant roots have bound the upper layers together so that the soil is no longer moved about by wind action. Nevertheless, because of its droughtiness, addition of enough fine material to this soil to protect crops from damage in prolonged dry spells is almost impossible, or impractical. The water-holding capacity of this soil is somewhat greater than its structure and permeability would indicate, and in seasons of normal rainfall crops and vegetables do remarkably well.

Use and management.—Most of Lakin loamy fine sand is in general crops, alfalfa, and vegetables. At the time of survey half of it was in vegetables, including potatoes, tomatoes, turnips, onions, beans, peas, asparagus, cantaloups, watermelons, sweet corn, peppers, and other garden vegetables. Yields are best in years of heavy rainfall. A few truck growers have provided protection against dry seasons by installing overhead irrigation systems.

Liberal quantities of high-grade fertilizers are used by most truck growers, and crops respond rapidly to such amendments and to manure. Suitable management practices are given for this soil in subgroup 1C of table 5.

Leck Kill channery silt loam (3-12% slopes) (L_B).—The parent materials of this well-drained shallow soil are weathered pre-Wisconsin till and residuum. They come from reddish-brown shale and sandstone of the Catskill formation, which occurs south of the North Branch of the Susquehanna River in three geological belts running east and west.

This channery silt loam (pl. 3, *B*) is associated with the deeper Rebuck soils, which developed on the same materials. Small spots transitional to the Rebuck soils are included with it. From one-fourth to three-fourths of the surface soil of Leck Kill channery silt loam has been lost from cleared areas. No gullies were evident at the time the soil was mapped.

In cleared areas the soil consists of brown friable channery silt loam to depths of 6 to 8 inches, where it is underlain by reddish-brown to reddish-yellow clay loam or silty clay loam. This reddish-brown subsoil layer is less well developed and more brightly colored than the corresponding layer in Rebuck silt loam. The weathered parent material, which generally begins at 24 to 36 inches, consists of light reddish-brown silty soil material and thin angular fragments of red and brown shale. Many shale fragments up to 3 or 4 inches wide and 1 inch or so thick are also encountered in the upper layers of this soil (pl. 4), but they do not materially interfere with cultivation.

Numerous tests for acidity indicate a reaction ranging from extremely to strongly acid in the subsoil and parent material. In most places the shale formation offers considerable resistance to root penetration at depths below 24 inches, but underdrainage is not obstructed; in other places the subsoil and parent material are more porous and permeable.

Use and management.—All crops grown in this section are adapted to Leck Kill channery silt loam. At the time of survey 65 or 70 percent of it was in cultivation, 3 percent in pasture, and 25 or 30 percent in forest. About 2 percent was idle. Fruit trees thrive on this soil where danger from frost is limited.



- A. Corn on Kreamer cherty silt loam, eroded phase, about $\frac{1}{4}$ mile southwest of Urban. The mild hummocky relief is typical of this soil. Weikert soil is on ridges and steep slope.
- B. Strip cropping on long slope of Reback silt loam, eroded phase. Gullies have been checked and filled up. (In cornfield at left gullies have formed.) Ridge in background is mostly Leck Kill channery silt loam about 1 mile south of Rushtown.
- C. Deep gullies on lower slopes of Leck Kill channery silt loam, eroded hilly phase, about $\frac{1}{2}$ mile west of Kilnes Grove. Even pastures, unless well fertilized and not overgrazed, will not control erosion on lower slopes. Pasture cover shown consists mostly of coarse grasses.



Profile of Leck Kill channery silt loam about $\frac{1}{2}$ mile east of Klines Grove, showing $2\frac{1}{2}$ feet of soil material over shale. The subsoil is not so heavy as in the Rebuick soils and contains more shale fragments.

This silt loam responds to good farming practices and can be built up to fairly high productivity. Maintaining productivity at a satisfactory level probably will require a fairly long rotation that includes 2 years of a legume or grass-legume mixture. The soil is deficient in lime, nitrogen, phosphorus, and potassium for high yields of most crops. Terraces and contour tillage will aid in controlling erosion if the soil is used for row crops. Management practices suitable for this soil are listed under subgroup 3B in table 7.

Leck Kill channery silt loam, eroded hilly phase (20-35% slopes) (Lo).—This soil is hilly to steep. In cleared areas the surface soil is thinner and more gullies (pl. 3, C) have formed than on Leck Kill channery silt loam, and from one-half to all of the surface soil and part of the subsoil have been lost through accelerated erosion.

Use and management.—At the time of survey approximately 75 percent of this soil was used for crops, 5 percent was in pasture, and the rest was in timber. Most of the cropland is in corn and hay, as it is too steep for combines or binders. Average crop yields are considerably below those on Leck Kill channery silt loam.

The soil is best suited to pasture or hay; it is poorly suited to crops requiring tillage, mainly because of strong slopes and high susceptibility to erosion. See subgroup 8B in table 12 for suitable management practices.

Leck Kill channery silt loam, eroded phase (3-12% slopes) (Ln).—This phase differs from Leck Kill channery silt loam in degree of erosion; it has lost slightly more of its original surface layer because of gullying. Shallow gullies, most of them more than 100 feet apart, occur in all of the fields. A few fields have gullies only 50 to 100 feet apart. Most of the gullies can be crossed by heavy farm machinery.

Use and management.—When this survey was made all of Leck Kill channery silt loam, eroded phase, had been cleared. Except for small patches seeded to pasture grasses and others that had reverted to forest, it was used for row crops, fruits, and vegetables. Crop yields are nearly the same to about 5 percent lower than those ordinarily obtained on Leck Kill channery silt loam. Crop suitability, soil amendments, and management practices are similar for both soils, although more organic matter should be returned to this eroded phase where erosion losses are greatest. See subgroup 3B in table 7 for suitable management practices.

Leck Kill channery silt loam, eroded rolling phase (12-20% slopes) (Le).—Because of greater slope, this phase has slightly thinner surface soil, a greater number of gullies, more difficult tillage, and less organic matter than Leck Kill channery silt loam. The lower layers of the two soils, including the underlying formations, are similar.

Use and management.—At the time of survey about 80 percent of Leck Kill channery silt loam, eroded rolling phase, had been cleared. Crop adaptations and the soil amendments required are somewhat similar to those for Leck Kill channery silt loam, but yields are 5 to 10 percent lower and management problems are more difficult. Contour plowing, strip cropping, and more extensive use of close-growing

crops are necessary to maintain the surface soil and prevent gullies on the more sloping areas. Suggested management practices are given under subgroup 4B in table 8.

Leetonia stony loamy coarse sand (5–25% slopes) (Lr).—This soil occurs on smooth areas on the tops of high mountains and is the most thoroughly leached of the mountain soils. It has developed on material residual from acid gray sandstone and quartzite or weakly metamorphosed quartzite.

The soil is covered by a dark-brown to black raw humus layer about $\frac{1}{2}$ to 1 inch thick. Below the humus is a light-gray leached mineral surface layer consisting of sharply angular sand derived largely from quartzite rock materials. This layer ranges from 1 to 6 inches thick and averages about 3. A thin dark-brown zone ranging in thickness from $\frac{1}{2}$ to 2 inches occurs below the light-gray leached layer. Between depths of 8 and 24 inches begins a yellowish-brown porous friable sandy loam containing numerous sandstone and quartzite fragments. The parent soil material, consisting of yellow to grayish-yellow loamy sand and sandstone and quartzite stones, occurs below a depth of 24 inches. This parent material is residual from the underlying bedrock. Bedrock is at variable depths but in most places occurs within 3 feet of the surface.

The soil material is extremely acid throughout. Both the organic-matter content and the water-holding capacity are low because of the loose subsoil.

Use and management.—This stony loamy coarse sand is not an agricultural soil; it is too stony and droughty for crops, fruit, or pasture. The dominant vegetation is small chestnut oak and scarlet oak. Huckleberries, blueberries, and mountain-laurel grow beneath the scrubby trees. This is the poorest soil in the mountains. Tree growth is slow. This soil is in management group 9 (see table 13).

Lickdale stony silt loam (2–6% slopes) (Lg).—Poorly drained positions in the more mountainous areas are occupied by this soil. For the most part, it has developed from residual material where associated with the Leetonia soil and from pre-Wisconsin till and residuum where associated with the Fleetwood soils. A few small patches near the base of mountain slopes have developed from colluvial material from Rough stony land (DeKalb soil material).

The surface soil is gray to dark-gray friable heavy loam to silt loam to depths of 10 to 12 inches. The subsoil is mottled gray, yellow, yellowish-brown, or bluish-gray slightly plastic clay loam. This is underlain at depths of 30 to 36 inches by a mass of gray sandstone, shale, and mottled soil material. Fragments of shale and sandstone are scattered over the surface and imbedded in the subsoil.

This soil is very strongly to extremely acid throughout. The quantity of organic matter in the surface soil is large, but it is only partially decomposed. The surface soil remains wet long after rains, and the subsoil is saturated most of the year.

Use and management.—Seepage water from the higher lying soils, together with stoniness, restricts this soil to forest. The forest growth is mainly beech, maple, elm, and oak; the undergrowth consists largely of sedge, cattail, mountain-laurel, and water-loving plants. Fair pasture probably could be obtained by draining excess water from the

upper soil layers. It is better suited to forestry, however. This soil is in management group 9, as shown in table 13.

Lindside sandy loam (0-3% slopes) (LH).—Low positions and swales on the flood plains of the West Branch of the Susquehanna River are occupied by this imperfectly drained soil. Where the soil occurs on small islands or in low positions next to the river, it is often subjected to overflow during the growing seasons as well as in spring. Areas a considerable distance from the channel are generally subject only to spring overflows from the river, but they receive considerable surface flow from adjoining higher lying soils. Some relief from excess water is obtained by the rapid downward percolation through the porous soil material.

This soil differs from Lindside silt loam in having coarser texture and lower lime content. It is moderately to strongly acid throughout and generally lower in plant nutrients than Lindside silt loam.

Use and management.—At the time of survey about 60 percent of Lindside sandy loam had been cleared and was being used largely for crops. About 40 percent was in forest, primarily because of its wetness and frequent inundation. Corn, hay, and soybeans—the principal crops—yield slightly less than on Lindside silt loam. This soil is less suitable for pasture than Lindside silt loam. Drainage ditches to lower the water table and remove excess water faster would increase the value of this soil considerably, as it would allow deeper rooting of plants and thereby widen crop suitability. Phosphorous and potassium are likely not available in quantities sufficient for maximum yields of either field crops or pasture. See subgroup 6B in table 10 for suitable management practices.

Lindside silt loam (0-3% slopes) (LK).—This soil occupies imperfectly drained positions on the flood plains. It occurs in association with the Ashton, Huntington, Melvin, and Chilo soils. The parent material was washed from uplands and terraces underlain by limestone, calcareous and acid shale, and sandstone. Lindside silt loam differs from Middlebury silt loam principally in having a higher content of lime, but it also contains a larger supply of most other plant nutrients.

The surface soil, extending to depths of 8 to 12 inches, is grayish-brown or dark grayish-brown mellow silt loam. A light yellowish-brown color, indicating good internal drainage and effective aeration, is apparent to depths ranging from 12 to 24 inches; but below this depth range the gray or mottled gray and yellow color indicates prolonged periods of saturation. The upper subsoil is friable but the lower subsoil is slightly sticky and plastic. The texture of the subsoil is variable, ranging from silt loam to silty clay.

Runoff on this soil is moderately slow, and the depth to which good drainage extends differs somewhat from place to place. Saturation of the lower subsoil for a large part of the year results from the level surface of the soil and its position with respect to adjacent soils and the stream bed. Where the soil occurs on the river bottoms, it is mostly moderately acid in the upper layers and strongly acid in the lower subsoil and substratum. Where it occurs on the small stream and creek bottoms, it varies from moderately acid to about neutral, according to the amount of leaching and limestone influence.

Use and management.—At the time of survey an estimated 45 percent of Lindside silt loam was being used for crops, mainly corn and mixed hay. A small part was in other crops, as wheat, oats, soybeans, and buckwheat. Nearly 20 percent was in forest, 30 percent was used regularly for pasture, and a small part was idle. Oats lodge considerably because of the large supply of organic matter and nitrogen in the soil. Pastures have more Kentucky bluegrass and white clover and in general fewer coarse grasses and weeds than the more acid Middlebury soil or the associated more poorly drained Melvin and Dunning soils, which occur on similar parent materials.

Areas of this soil occurring on the river bottoms are somewhat coarser textured and probably slightly lower in most plant nutrients than those along small stream and creek bottoms. The river-bottom areas are not overflowed so frequently and therefore are used to slightly greater extent for crops. The areas occurring along the creeks produce better pasture because they have a liberal supply of lime, but most of them are overflowed 1 year out of 2. A few areas can be used for winter-sown grains without serious risk of inundation.

To considerable extent, red clover freezes out, and it is occasionally damaged by floods. Alfalfa is not suited, because of the high water table as well as the risk of damage from overflow. Leafy vegetables do well, but the soil is poorly suited to tomatoes or potatoes. Little fertilizer is required, although most areas will respond to applications of phosphate and potash. Lime is beneficial in places.

Lindside silt loam is especially valuable for pasture because it is moist and productive through dry periods when pasture on the upland soils is short. Suitable management practices will be found in subgroup 6B of table 10.

Lycoming stony loam (10–25% slopes) (LL).—This soil has developed from colluvial material in well-drained positions on lower slopes or at the base of mountains. The parent material came from acid gray sandstone and quartzite and is very similar to the rock material from which it came.

The surface soil, 7 to 10 inches deep, consists of yellowish-brown or pale-yellow very friable loam. The subsoil is dusky-yellow or yellowish-brown friable heavy loam to sandy clay. Underlying the subsoil at depths of 30 to 36 inches is the light-brown or yellowish-brown compact parent material. The entire soil mass contains a considerable quantity of angular and subangular sandstone fragments and rock boulders.

Both the soil and parent material are highly leached, extremely acid, and low in plant nutrients. The soil has a fair water-holding capacity and is well aerated. Because of its depth and position, it is superior to the Leetonia soil on the higher lying slopes and ridges.

Use and management.—Practically all of Lycoming stony loam is forested. The principal trees are hemlock, white pine, red, scarlet, and white oaks, maple, and elm. Scattered jack pines and yellow-poplars are encountered. Trees grow better than on the other soils of the mountains except the Fleetwood.

Because it is stony, sandy, and somewhat droughty, this soil is not suited to pasture grasses and is most valuable for timber. See group 9 in table 13 for specific suggestions on management.

Made land (0-3% slopes) (M).—The term "Made land" is applied to soil material recently moved by artificial means, such as that in road fills, quarry dumps, and clay and gravel pits. This material has not developed enough to form a true soil and has little or no agricultural value.

Mazeppa silt loam (3-12% slopes) (MA).—Although this well-drained soil is very similar to Norton silt loam, its parent material consists largely of shallow pre-Wisconsin till and residuum over calcareous red shale, whereas that of Norton silt loam is for the most part from acid red shale. The influence of the local red shale of Mazeppa silt loam is greater than that of the weathered materials of pre-Wisconsin age and, except for depth and subsoil development, this soil closely resembles the associated shallower Northumberland soils, which developed from similar material.

The surface soil, a weak reddish-brown friable silt loam, extends to depths of 4 to 8 inches. The depth depends on the amount of soil lost through erosion. The subsoil is reddish-brown friable silty clay loam or clay loam with a weakly developed platy structure. Beginning below a depth of 30 or 36 inches is the weathered pre-Wisconsin till or residuum, which is made up of reddish-brown shale fragments and reddish-brown clay loam soil material.

The soil varies in depth and in content of rocks other than red shale. In some places the total thickness of the soil material is not more than 24 inches, but in most places it ranges from 3 to 6 feet in thickness. A few angular and rounded shale fragments are mixed with the surface soil and subsoil; the quantity increases with depth. In a few areas, indicated on the soil map by symbol, the shale fragments make up more than 25 percent of the surface layer.

This soil is moderately to strongly acid; the Bloomsburg red shale that underlies it is weakly calcareous. Moisture facilities are good throughout; aeration and permeability are adequate but not excessive; and deep-rooted plants easily penetrate the subsoil layers. The productivity of this soil indicates that it has a more liberal supply of plant nutrients, especially calcium, than Norton silt loam.

Use and management.—At the time of survey more than 90 percent of the Mazeppa silt loam was being used for all the types of crops grown in the two counties. Less than 5 percent was pasture, and small blocks were in forest or abandoned.

This is a soil well suited to pasture, and to all crops, including alfalfa and vegetables. It is actually reasonably fertile, but crops respond well to fertilizers and lime. With its favorable tilth and moisture relations, large yields can be produced consistently. Suitable management practices are suggested under subgroup 1A in table 5.

Mazeppa silt loam, eroded rolling phase (12-20% slopes) (MB).—Because this soil occupies more sloping areas, cultivated fields have been subjected to more erosion than on Mazeppa silt loam, which occurs on milder slopes and divides. The original surface soil is consequently a little thinner and the supply of organic matter slightly lower. Otherwise the two soils are similar. In a few spots this eroded phase has lost practically all of its surface soil and gullies have cut into the subsoil. These gullied and eroded areas are shown on the soil map by symbol.

Use and management.—At the time of survey, soybeans, alfalfa, and vegetables were being grown on about 85 percent of this eroded rolling phase. The rest was partly in pasture, partly in forest, and partly abandoned. Crops yield 5 to 10 percent less than on Mazeppa silt loam; the actual yield depends on past and present management.

For most of the common field crops and pasture, this soil is fairly suitable. It is not so desirable for crops as Mazeppa silt loam, but its use and management requirements are somewhat similar. Longer rotations that include legumes and grasses more of the time, as well as liberal applications of needed plant nutrients, will be necessary to maintain crop yields. Suitable management practices are suggested in subgroup 2A of table 6.

Melvin sandy loam (0-3% slopes) (Mc).—Nearly all of this sandy loam occurs in low strips or swales on the river bottoms. Although it is not overflowed every year, surface and seepage waters from higher lying land settle on this soil and keep it saturated a large part of each year.

A coarser surface texture differentiates this soil from Melvin silt loam. This sandy loam responds better to artificial drainage and fertilization. It is lower in most plant nutrients than Melvin silt loam. Its reaction, as indicated by field tests, ranges from medium acid to mildly alkaline in both the surface soil and subsoil.

Use and management.—Without artificial drainage Melvin sandy loam is too wet for production of most crops. A few open ditches have been dug on the cleared areas to provide quicker runoff and lower the water table to some extent. At the time of survey about 40 percent of this soil was in crops, mainly corn, soybeans, and mixed hay. Another 40 percent was in forest, and most of the rest was used for grazing. Crop yields are low; they depend largely on the amount of artificial drainage provided. This soil is much less valuable for pasture than Melvin silt loam; only coarse tall grasses thrive on it. Nevertheless, this sandy loam has a good supply of organic matter, and it would produce moderate yields of corn and leafy vegetables if adequately drained. The addition of lime is beneficial in some places. See group 7 in table 11 for suitable management practices.

Melvin silt loam (0-3% slopes) (Md).—Most of this silt loam occurs on poorly drained land on first bottoms along streams in the areas where the adjacent soils have developed from parent materials washed from uplands underlain by limestone, calcareous shale, and acid sandstone and shale. Associated with this soil are the well-drained Huntington, the imperfectly drained Lindside, and the very poorly drained Dunning soils, which developed from similar materials. Practically all of this silt loam is subjected to stream overflow. Seepage water from higher lying soils keeps the soil wet long after the streams have subsided. Except near the stream banks, however, little deposition takes place.

The surface soil, 8 to 12 inches deep, is dark or slightly gray plastic silt loam to silty clay loam that contains considerable organic matter. The subsoil is gray slightly plastic clay loam to silty clay with splotches of yellow and brown. In some places the subsoil is gray to bluish gray—colors common to soil materials in which saturation prevents complete oxidation of any iron present.

In most places the surface soil and subsoil vary from moderately acid to slightly alkaline. The level of the water table depends largely on the stage of the stream but it is seldom more than 36 inches from the surface and is generally much nearer.

Use and management.—At the time of survey about 65 percent of Melvin silt loam was in permanent pasture. About 20 percent was used for crops, 10 percent was in forest, and 5 percent was idle. The good supply of lime and other plant nutrients favor the growth of Kentucky bluegrass, white clover, and other pasture grasses, although coarse grasses predominate in the wetter spots.

Some narrow strips developed in swales in the bottom lands of the West Branch of the Susquehanna River are lighter textured, strongly acid, and lower in most plant nutrients than areas of the soil along the other streams. As a result a larger proportion of these wetter areas are in forest or idle than is usual for the areas along the creek bottoms.

Lowering of the water table 6 inches to 1 foot by artificial drainage would considerably increase the value of this soil for both pasture and crops. It is doubtful that fertilizers would be profitable on this soil in its present drainage condition. Only the better drained areas or those that have ditches to carry off excess water should be used for crops. See group 7 in table 11 for suitable management practices.

Mertz cherty silt loam (3–8% slopes) (Me).—This well-drained soil occupies ridges and mild slopes in the cherty limestone areas of both counties. Its parent material was weathered deep pre-Wisconsin till derived from cherty limestone. The soil is associated with other Mertz soils and with the Elliber and Kreamer soils. Its mild relief favors the use of heavy farm machinery. Good internal drainage, aided by a large quantity of chert fragments in the soil, tends to keep down erosion. In most places only one-fourth to one-half of the original surface soil has been lost and gullies are not noticeable.

The surface soil is grayish-brown, gritty, porous light silt loam; it is 4 to 8 inches deep, the thickness depending on erosion losses. Below this layer and extending to a depth of 30 inches is yellowish-brown porous friable silt loam. Next in profile is the weathered pre-Wisconsin till parent material, a light yellow to yellowish-red silt loam with a moderately developed subangular structure. In places this till is heavier textured and has a moderate blocky structure.

The friability and porosity of this soil are partly caused by the cherty fragments that constitute 15 to 25 percent of the surface layer and 20 to 40 percent of the subsoil and substratum.

This soil is highly leached of soluble plant nutrients, very strongly to extremely acid throughout, and moderate in content of organic matter and nitrogen. It is lower in inherent fertility than the heavier soils derived partly from higher grade limestone materials, but is probably richer in most plant nutrients than the soils derived largely from glacially worked acid shale. It is easily penetrated by roots, air, and moisture, yet has fairly good moisture-holding capacity.

Use and management.—Mertz cherty silt loam is used largely for general field crops such as corn, wheat, oats, and mixed hay. Some soybeans, alfalfa, fruit, and vegetables are also grown. At the time of survey nearly 15 percent was in forest, and about 5 percent was partly in pasture and partly idle. Although it is one of the best soils

in this area for fruit production, it is not used extensively for that purpose. The soil is recognized as fair for corn. Because the soil is light, it is not so well suited to wheat, timothy, oats, and grass as it is to corn, clover, alfalfa, fruit, and vegetables.

This soil is deficient in lime, phosphorus, nitrogen, and potassium for most crops. It responds well when these are applied, but the improvement is not so lasting as on some other soils. Erosion control is not difficult if a suitable rotation is used. Contour tillage and strip cropping are beneficial. Suitable management practices are given in subgroup 1A of table 5.

Mertz cherty silt loam, eroded hill phase (15-30% slopes) (Mr).—This soil is on single generally smooth slopes on the sides of the cherty limestone ridges. Because of its greater slope, it has lost more soil and organic matter than Mertz cherty silt loam. In most places one-half to all of the surface soil has been lost and shallow and deep gullies are common. Several small severely eroded patches are indicated on the soil map by symbol; they have lost practically all of the surface soil and some of the subsoil, and gullies are less than 100 feet apart. In contrast, some areas too small to map separately are practically uneroded.

Use and management.—At the time this survey was made, nearly 75 percent of Mertz cherty silt loam, eroded hill phase, was in crops, chiefly corn, oats, wheat, mixed hay, and alfalfa. About 15 percent was forested; more than 5 percent was idle, and less than 5 percent was in pasture grasses. Crops probably yield 15 to 20 percent less on this soil than on the more mildly sloping Mertz cherty silt loam.

This phase has less favorable workability than Mertz cherty silt loam and is more difficult to conserve. Its crop adaptations are narrower, and a higher percentage of legumes and grasses is required in the rotation to maintain productivity.

Row crops should not be planted if their use can be avoided, as it is practically impossible to prevent erosion where they are grown. Although the soil is not highly productive of forage, pasture is probably its best use on many farms. Lime and phosphate fertilizer are necessary for pastures. See subgroup 8A in table 12 for suitable management practices.

Mertz cherty silt loam, eroded phase (3-8% slopes) (Mg).—This phase differs from Mertz cherty silty loam only in having lost greater quantities of soil material and organic matter. From one-fourth to three-fourths of the original surface soil has been lost, and shallow gullies more than 100 feet apart have formed in all fields. A few deep gullies have developed in several places where protection from erosion has been neglected.

Use and management.—Practically all of this eroded phase had been cleared at the time of the survey. Except for about 5 percent that was partly idle and partly in pasture, the soil was used mostly for crops, fruits, and vegetables. Owing to greater soil loss and somewhat faster runoff, this phase produces slightly lower average yields than Mertz cherty silt loam. Erosion, however, is not serious and can be controlled on these mild slopes by simple practices that do not involve much modification in the rotation. Strip cropping, contour tillage, proper choice and rotation of crops, and application of necessary soil

treatment are required. See subgroup 1A in table 5 for suitable management practices.

Mertz cherty silt loam, eroded rolling phase (8-15% slopes) (MН).—The slopes of this phase are stronger than those of Mertz cherty silt loam. Also, in most places, the surface soil is thinner, and in a few places all of it has washed away. Shallow gullies occur in all the fields; deep gullies have been allowed to form in a few places. Average tilth is slightly inferior to that of Mertz cherty silt loam because of the gullies and the lower content of organic matter. The subsoil, substratum, and parent material of the two soils are similar.

Use and management.—Only a small total area of Mertz cherty silt loam, eroded rolling phase, occurs in the two counties and practically all of it is cleared. At the time of this survey an estimated 95 percent was used for crops, fruits, and vegetables; 5 percent was partly idle and partly in pasture grasses. Crop yields are ordinarily 10 to 15 percent lower than on Mertz cherty silt loam, and about 5 percent lower than on Mertz cherty silt loam, rolling phase. Fertilizer requirements are nearly the same as on those soils. Contour tillage, strip cropping, and increased production of legumes and hay crops are necessary to conserve this soil and maintain productivity. See subgroup 2A in table 6 for suitable management practices.

Mertz cherty silt loam, rolling phase (8-15% slopes) (Mк).—Because it has stronger slopes, this phase has faster runoff than Mertz cherty silt loam and tends to erode more rapidly in cleared areas. From one-fourth to three-fourths of the original surface soil has been lost, and the supply of organic matter has been lessened by erosion. Most of this rolling phase occurs in association with the other Mertz soils and with the Elliber, Sedan, and Kreamer soils.

Use and management.—At the time of survey about 85 percent of this rolling phase was under cultivation. About 10 percent was in forest, and more than 5 percent was seeded to pasture grasses. Crops yield 5 to 10 percent less than they normally do on Mertz cherty silt loam, which is more mildly sloping. Fertilizer requirements are similar for the two soils, but close-growing crops should be grown more extensively on this rolling phase for protection against soil wash and runoff. See subgroup 2A in table 6 for suitable management practices.

Middlebury silt loam (0-3% slopes) (Mл).—This soil occupies overflow land along the small streams of the counties and the North Branch of the Susquehanna River. The materials have washed from glacial deposits derived from sandstone, shale, and quartzite. Drainage is imperfect because of the low position of the soil with respect to the stream channel and surrounding soils. The soil is associated with the well-drained Tioga and the poorly drained Holly soils, which developed from similar materials.

The 8- to 14-inch surface soil is grayish-brown friable silt loam. At depths ranging from 10 to 24 inches the light yellowish-brown color indicates good internal drainage and effective aeration, but below this range the gray or mottled gray and yellow color shows that the subsoil is frequently saturated. Subsoil saturation prevails not only in winter and early in spring when the streams are at a high stage but often during rainy periods in summer and autumn. The texture of

the subsoil and substratum is variable, ranging from loam to silty clay loam. Some rounded pebbles are mixed with the soil in areas along small streams but are not numerous enough to interfere with tillage.

The Middlebury soil is moderately to very strongly acid. It is fairly well supplied with organic matter and other plant nutrients, but imperfect drainage and damage from overflow narrow the crop adaptation and decrease yields.

Use and management.—Most of Middlebury silt loam occurs along small streams and is subjected to overflow nearly every year. An exception is the area along Shamokin Creek and the North Branch of the Susquehanna River, which is only occasionally overflowed and may be used successfully for fall-sown grains as well as corn, oats, and hay. At the time of the survey all areas occurring along the river were cleared and used regularly for crops; but about 40 percent of the area along other streams was in forest, 10 percent was idle, 25 percent was in pasture, and only 25 percent was used for crops. Yields of corn and mixed hay are nearly the same, however, in both locations.

This soil is not suited to alfalfa or fruit trees. Red clover and wheat freeze out considerably and are susceptible to damage from inundation. Pasture grasses do well. Lime and phosphate and potash fertilizer are beneficial for pasture as well as for most crops. See subgroup 6B in table 10 for suitable management practices.

Mifflinburg silt loam (3-8% slopes) (Mm).—Broad low ridges and gentle slopes are occupied by this soil, which developed under well-drained conditions from pre-Wisconsin till and residuum that came principally from gray calcareous shale. Associated with this soil are the well-drained shallow Kutztown soils developed from similar materials.

In cultivated fields Mifflinburg silt loam consists of the following layers: (1) Grayish-brown to light-brown mellow silt loam to depths of about 4 to 7 inches, (2) light yellowish-brown friable silty clay loam from depths of 7 to about 14 inches, (3) yellowish-brown (spotted with black in many places) slightly compact silty clay extending from about 14 to 24 inches, and (4) mixed silty clay from pre-Wisconsin till and residuum that contains broken chips of weathered gray shale and extends from about 24 to 36 inches. Thin platy partly disintegrated shale underlies the soil material. In some areas considerable glacial material from other geological formations forms a part of the soil. Gravel and shale fragments are mixed with the soil in these places but do not change its character or interfere with cultivation. These gravelly and shaly areas are shown on the map by symbol.

The soil is moderately acid in the upper layers, but neutral to alkaline in the lower part. It is well drained both on the surface and internally and has good moisture conditions.

Use and management.—A few small patches of Mifflinburg silt loam were in woods and pasture at the time of the survey, and about 95 percent was used for crops.

This is an exceptionally desirable upland soil for crops or pasture. It is well suited to all of the common crops, and especially well suited to alfalfa and other deep-rooted legumes. Conditions for the

maintenance of good tilth are fairly good. Although the soil is moderately productive under the present management, it responds to better management practices. It does not have enough phosphorus and nitrogen for high yields of most crops. The supply of potassium is also likely to be limited for some crops, especially vegetables and legumes. Legumes, moreover, would benefit from moderate applications of lime. The soil is slightly to moderately susceptible to erosion; some practices for water control are necessary to maintain its fertility. This soil is in management groups 1A of table 5.

Mifflinburg silt loam, eroded phase (3-8% slopes) (M_N).—This soil is similar to Mifflinburg silt loam except that it has shallow gullies in all fields. Most of the gullies are more than 100 feet apart, and a few are relatively deep. Surface erosion is moderate; from one-fourth to three-fourths of the original surface soil has been lost.

Use and management.—Crop yields on this eroded phase range from 2 to 5 percent lower than on Mifflinburg silt loam. Since the soil is in great demand for crops and only a few small patches are in pasture, erosion cannot be entirely prevented. Measures that permit the most complete use for crops with the least possible loss of soil through erosion are therefore needed. Contour tillage, terracing, and strip cropping should be practiced where feasible. Rotations should include 2 or more years of a legume-and-grass crop. Intertilled crops should not be grown more than 2 years in succession. See subgroup 1A in table 5 for suitable management practices.

Mifflinburg silt loam, eroded rolling phase (8-18% slopes) (M_o).—This soil has the same general characteristics as Mifflinburg silt loam. Runoff and erosion are more difficult to control, however, because relief is stronger and erosion greater. A few tracts that have lost practically all of the surface soil and have been gullied at frequent intervals are indicated on the soil map by symbol. Several areas of similar soil not appreciably eroded, as well as several small areas that have slopes somewhat greater than 18 percent, are included with this soil.

Use and management.—Estimates at the time of the survey showed that general crops, soybeans, and alfalfa were grown on about 90 percent of this eroded soil. Less than 5 percent was in forest, and nearly 5 percent was used for permanent pasture. Crop yields are about 5 to 10 percent lower than on Mifflinburg silt loam. On the steeper slopes, elimination of wheat or oats from the crop rotation probably would be desirable.

This soil is fairly well suited to most crops and pasture plants of the area. It is less desirable, however, than Mifflinburg soils on milder slopes; it requires more exacting management, as it is lower in organic matter and plant nutrients and more susceptible to erosion. A longer rotation consisting to greater extent of legumes and grasses is necessary to maintain crop yields. Contour tillage and strip cropping should be practiced for erosion control. Nitrogen, phosphate, and potash applications are essential for high yields, and small amounts of lime are especially beneficial to legumes. See subgroup 2A in table 6 for suitable crop rotations.

Mine dumps (M_P).—Dumps from coal mines in the hard-coal region of Northumberland County make up this land type. They

consist of piles of rock, soil material, and shaly or slaty coal material practically worthless for fuel. A few small dumps from iron mines on Montour Ridge are also included. Land occupied by mine dumps and mine pits has no present use for crops or pasture and supports little or no forest or other vegetation.

Montgomery silty clay loam (0-3% slopes) (Mr).—This poorly drained dark heavy soil occupies terraces in the limestone and calcareous shale sections of the two counties. It is closely associated with the Williamsburg soil, and in some places with the Chillisquaque. It has developed from alkaline silts and clays deposited by streams that flowed in areas underlain by limestone and calcareous shale.

The surface soil, 8 to 12 inches deep, consists of moderate-gray to almost black silty clay loam that is high in organic matter, granular in structure when dry, and slightly plastic when wet. The subsoil is a dominantly gray heavy plastic silty clay to clay with splotches of brown and yellow; it is practically impervious to roots, air, and moisture. Below depths of 30 to 40 inches most of this soil is calcareous.

Most areas are slightly acid in the surface soil and neutral or slightly alkaline in the subsoil. A few areas occurring along Delaware Run are moderately acid in the upper layers. Almost continuous saturation of the subsoil and consequent lack of oxidation prevail in areas where no drainage ditches have been dug.

Use and management.—At the time of the survey nearly all of Montgomery silty clay loam had been cleared but only about half of it was in crops. About 30 percent was in pasture, and 10 percent could be classed as idle. The rest was in forest. Crop rotations usually are not systematically followed; corn, timothy, and soybeans are the principal crops. Wheat, oats, and red clover are planted in some fields, but the fall-sown crops freeze out badly and oats lodge considerably because of the high nitrogen content. In general, corn, timothy, alsike clover, and pasture grasses do best on this poorly drained soil. Most of the pastures have a large proportion of coarse grasses, rushes, and weeds. Because of its wetness, this soil is not well suited to bluegrass and white clover. It is inherently fertile, however, and well supplied with lime and organic matter. Erosion is negligible in most places. When adequate drainage is provide, this soil is exceptionally productive. See subgroup 5C in table 9 for suitable management practices.

Natalie stony silt loam (4-10% slopes) (NA).—This imperfectly drained soil has developed on acid pre-Wisconsin till and residuum derived from acid gray quartzite. It occupies undulating areas of mild relief, mainly in the mountain valleys of southeastern Northumberland County, where it is associated with the Lickdale and Fleetwood soils. Most of the soil occurs below higher lying slopes and receives considerable seepage water.

The typical soil has an 8- to 10-inch surface layer of yellowish-brown or grayish-brown friable stony loam to stony silt loam. This layer is underlain by pale-yellow to moderate yellowish-brown friable sandy clay. Numerous angular shale, sandstone, and quartzite fragments are imbedded in the subsoil. Beginning at a depth of 20 inches and extending to 36 inches the subsoil is gray, yellow, and dull-brown, mottled, slightly compact clay loam. Some black splotches of coal and

carbonaceous materials are mixed with the subsoil. The underlying glacial till is derived principally from quartzite.

Use and management.—This soil, like the other soils of the mountainous areas, is extremely acid in all layers. It is fairly low in plant nutrients and is only fair in moisture conditions. These characteristics, combined with stoniness, render the soil unsuitable for anything but forestry. It is in management group 9, as shown in table 13.

Northumberland shaly silt loam, eroded hill phase (15–35% slopes) (Nb).—The surface soil on the cleared areas of this phase is slightly thinner than on the eroded rolling phase and gullying is more destructive.

Use and management.—At the time of the survey an estimated 25 percent of this eroded hill phase was in corn, wheat, and mixed hay. From 10 to 15 percent was in pasture grasses, and 10 to 15 percent was abandoned and had grown up in weeds and bushes. Farmers realize that most of this land should never have been tilled, as yields in normal years do not justify its use for intertilled crops.

This soil is best suited to pasture grasses. Shallowness, low water-holding capacity, hilly slopes, and high susceptibility to erosion are the limiting factors. Fair pastures can be established and maintained. Phosphate is the principal soil treatment needed. Supplies of lime and potash are fairly good. See subgroup 8A in table 12 for suitable management practices.

Northumberland shaly silt loam, eroded phase (3–8% slopes) (No).—The narrow strips and small tracts of this well-drained soil occur on smoother slopes in the red shale areas north of the North Branch of the Susquehanna River. The soil has developed on shallow residuum and pre-Wisconsin till derived principally from calcareous red shale. It occurs in association with the well-drained deep Maizeppa soils derived from similar materials.

The surface soil, extending to depths of 4 to 6 inches, is dusky reddish-brown friable gritty silt loam, 25 to 50 percent of which is thin platy red shale fragments. Partly weathered Bloomsburg red shale is reached at depths of 12 to 18 inches in most places. In some places there is incipient subsoil development, and 4 to 8 inches of pale reddish-brown silty clay loam lies between the surface layer and the shale formation. In many places, however, this layer is absent. The soil material in all horizons has a purplish cast, more noticeable in the shale than in the soil, which has been darkened by organic matter.

The parent material is slightly acid in most places, but the underlying shale is alkaline to weakly calcareous. The soil is droughty; root penetration into the shale formation is very limited. In cleared areas, most of the original organic matter has been lost because a large amount of surface soil has been carried away by erosion. Runoff is excessive. Shallow gullies form quickly during heavy rains but are covered by tillage operations.

Use and management.—At the time of the survey an estimated 75 percent of Northumberland shaly silt loam, eroded phase, was being used for crops. About 10 percent was in permanent pasture, and from 10 to 15 percent was idle or used as pasture part of the time.

This soil is shallow and has low water-holding capacity. It will support a fair growth of pasture grasses and legumes. Phosphate is the main fertilizer needed for legumes. Nitrogen is also needed for

nonlegume plants; potassium is less likely to be limiting. See subgroup 3A in table 7 for suitable management practices.

Northumberland shaly silt loam, eroded rolling phase (8–15% slopes) (ND).—This phase differs from the Northumberland shaly silt loam, eroded phase, in occupying steeper slopes on the sides of ridges. In consequence, it has greater runoff, a thinner surface soil, and less organic matter. These differences in the two soils are slight, however, and in other characteristics they are similar.

Use and management.—At the time of the survey an estimated 60 percent of Northumberland shaly silt loam, eroded phase, was used for general crops, soybeans, and alfalfa. About 30 percent was in forest, and the rest was idle most of the time. Crop yields average 5 to 10 percent below those obtained on the eroded phase of Northumberland shaly silt loam, and conservation and management are necessarily more complex. In some places gullies are too deep to be covered during tillage.

Good management for this shallow rolling phase is based chiefly on the needs for preventing further erosion and improving moisture conditions. Treatments should provide phosphorus, nitrogen, and organic matter, the chief nutrients limiting plant growth. Lime and potassium are not likely to be deficient. Pasture grasses and close-growing legume-and-grass crops should occupy the soil at least a third of the time. See subgroup 4A in table 8 for suitable management practices.

Norton gravelly loam (3–12% slopes) (NE).—This soil occurs as narrow strips in glaciated valleys. It is closely associated with Norton silt loam but differs from that soil in having more sand, gravel, and small stones in the upper layers. The stones and shale fragments range from 2 to 8 inches in diameter and make up 20 to 40 percent of the surface layers. They interfere with tillage in many places but do not make cultivation impractical. Surface relief is mild enough for the use of all farm machinery (see pl. 2, C). Erosion is slight—from one-fourth to one-half of the surface soil has been removed from cleared areas.

Use and management.—The moisture retentiveness of Norton gravelly loam is not so great as that of Norton silt loam; consequently, crops are adversely affected during prolonged dry weather. At the time of the survey only about 35 percent of this gravelly soil had been cleared. Of the cleared land, about 5 percent had been abandoned and a few patches were in permanent pasture.

Most kinds of crops common to the area are grown in this soil, although it is not especially well suited to shallow-rooted ones such as wheat, rye, and pasture grasses. Clover and alfalfa do well where lime is used liberally. Potatoes, tomatoes, and soybeans are grown successfully.

Where this soil occurs in dissected areas too far from mountains to have been influenced by colluvial material, it is more silty and has a better water-holding capacity than typical. Crop yields in these areas are essentially the same as on Norton silt loam.

In general, Norton gravelly loam is only moderately well supplied with plant nutrients and responds well to good management. It is too low in lime, nitrogen, phosphorus, and potassium to produce high

yields of practically all crops. This soil is in management subgroup 1B of table 5.

Norton gravelly loam, eroded phase (3–12% slopes) (Nr).—This phase differs from Norton silt loam in erosion losses and in having a higher content of gravel and sand in the upper layers. Erosion has been active on all areas. From one-half to all of the original surface soil has been lost in most places, and shallow gullies are common in all fields.

Use and management.—Practically all of this gravelly loam has been cleared and most of it is used for general crops, soybeans, and alfalfa. A few small patches are idle, and several fields are in permanent pasture. Crop yields vary from about 5 to 10 percent below those ordinarily obtained on Norton silt loam.

Contour tillage, strip cropping, and terracing, where feasible, are needed to conserve the remaining soil. The slopes are not great, however, and if crop rotations, lime, fertilizer, and manure are properly used, erosion control is not a serious problem. See subgroup 1B in table 5 for further information on management.

Norton gravelly loam, eroded sloping phase (12–20% slopes) (Ng).—In this phase are former areas of Norton gravelly loam, sloping phase, from which erosion has removed from one-half to all of the original surface soil, and in many places part of the subsoil. Shallow gullies have formed in all fields, and deep gullies occur in some. This soil is similar to Norton gravelly loam, eroded phase, in surface soil, subsoil, and substratum but has undergone more accelerated erosion.

Use and management.—At the time of the survey practically all of the eroded sloping phase of Norton gravelly loam had been cleared. Nearly 90 percent was used for crops, and the rest was partly in pasture and partly idle. Yields are about 10 to 20 percent below those from the Norton gravelly loam on undulating areas.

This eroded sloping phase is not particularly well suited to intertilled crops. Under a high level of management, an occasional row crop can be grown safely. The crop rotation, however, would need to be long and consist largely of legumes and grasses. Fertilization and liming are necessary for the successful growth of most crops or pasture. The soil is highly susceptible to further erosion. See subgroup 2B in table 6 for suitable management practices.

Norton gravelly loam, sloping phase (12–20% slopes) (Nh).—This phase is subjected to a little more erosion in cultivated fields and has slightly thinner surface soil (2 to 5 inches thick) than Norton gravelly loam, which is on milder slopes. Erosion is not serious, however, and gullies are rare. A large part of this soil occurs on slopes at the bases of mountains where stones and cobbles are numerous.

Use and management.—At the time of the survey only about 20 or 25 percent of this soil was cleared; 10 to 15 percent of this was used for crops, and 5 to 10 percent was idle. Runoff is greater, organic-matter content less, the soil more droughty, and crop yields about 10 to 20 percent less than on Norton silt loam. If used for crops, the management requirements for this soil would be similar to those for Norton gravelly loam, eroded sloping phase. See subgroup 2B in table 6 for suitable management practices.

Norton silt loam (3-12% slopes) (N_K).—This soil has developed on residuum and weathered pre-Wisconsin till over red shale formations. Erosion is slight; one-fourth to one-half of the surface soil has been lost from cleared areas.

The surface soil, a brown or pale reddish-brown very friable slit loam, extends to depths of 6 to 8 inches. The subsoil is reddish-brown friable silty clay loam or clay loam. Below 30 inches is compact weathered pre-Wisconsin glacial till that consists of weak-red shale fragments and reddish clay loam soil material. Some angular shale fragments are mixed with the surface soil and subsoil; these become more numerous with depth. The soil varies in depth. In some places the soil material is not more than 24 inches thick, whereas in others the shale bedrock is below depths of 6 to 8 feet.

This soil and the underlying red shale material are very strongly acid. In most places the profile has been influenced more by red shale than by the foreign material left by the glacier, and except for depth and subsoil development it closely resembles that of the shallower Klinesville soils. The surface soil and subsoil have a good moisture-holding capacity, yet the subsoil is easily penetrated by plant roots, air, and moisture.

Use and management.—Only about a third of Norton silt loam had been cleared at the time of the survey and the rest was in forest. It is not so productive as the Mazeppa soils; crop yields are nearly the same as those on the Allenwood and Re buck silt loams. The general crops of the area, as well as soybeans, potatoes, and tomatoes, are well suited.

This soil is fairly well suited to almost all crops grown in the area. It is only moderately well supplied with most plant nutrients, but is responsive to good management. Lime and complete fertilizer are necessary for the successful production of most crops. Good tilth is easily maintained, and erosion control is not difficult where good rotations are followed. Contour tillage is desirable. See subgroup 1B in table 5 for suitable management practices.

Norton silt loam, eroded phase (3-12% slopes) (N_L).—This phase differs from Norton silt loam in having lost more of its original surface soil and part of the subsoil through erosion. Shallow gullies have formed in all fields. The 2- to 5-inch surface soil is pale reddish-brown friable silt loam. The subsoil and substratum are similar to corresponding layers in Norton silt loam. In other characteristics, such as depth, position of development, and slope range, the two soils are alike.

Use and management.—Practically all of this eroded phase has been cleared and is used for crops. Because of the greater runoff and lower organic-matter content, yields are below those on Norton silt loam.

In management requirements, this soil is slightly more exacting than Norton silt loam. It has lost more soil through accelerated erosion. Crop rotations, fertilization, and lime requirements are similar to those used on Norton silt loam. Rotations that do not include a row crop should be considered. Where row crops are grown, contour strip cropping will reduce the susceptibility to runoff and erosion. This soil is fairly well suited to pasture. See subgroup 1B in table 5 for suggestions on management.

Pekin silt loam (0-3% slopes) (P_A).—This imperfectly drained soil occupies terraces formed by the larger creeks. The largest area is associated with the well-drained Elkinsville and poorly drained Bartle soils developed from similar material. Pekin silt loam is more extensive than Elkinsville silt loam.

The 8- to 10-inch surface soil is grayish-brown friable silt loam. In most places the upper subsoil is weak-yellow or light yellowish-brown friable silt loam. Below depths of 15 to 20 inches is a mottled gray and yellowish-brown slightly compact slowly pervious silt loam that remains wet a large part of the year. In some places, commonly along Schwaben and Mahantango creeks, where the soil has developed from materials washed largely from red-shale soil areas, the surface soil and upper subsoil are pale reddish brown. Where the soil is in valleys underlain by black shale, it is heavier than typical and has a silty clay lower subsoil. Another variation occurs in small areas indicated on the soil map by symbol. These have abundant rounded gravel in the surface layer. The thickness of the friable layers also varies; friability is good to a depth of 30 inches in some places.

In most places Pekin silt loam is very strongly acid in all layers. The organic-matter supply is moderate to low, and the soil is moderate in content of most plant nutrients. Surface drainage is fair, but subsoil drainage is slow. Penetration of roots, air, and moisture is good to depths of 15 to 24 inches.

Use and management.—At the time of survey about 85 percent of Pekin silt loam was used to produce the kinds of general crops grown in the two counties. Soybeans and buckwheat were also grown. Nearly 10 percent was in pasture grasses and about 3 percent in forest. Approximately 2 percent was idle. Crops yield nearly the same as or slightly higher than they do on Scioto silt loam, which in many respects is similar to this soil. Alfalfa yields only about a third as much as on well-drained soils of equal inherent fertility.

This soil can be used intensively for selected crops. It responds fairly well to fertilization, although the response is generally less than that on better drained soils. Applications of lime and of phosphate, nitrate, and potash fertilizers are the chief requirements in maintaining high yields. Slopes are mild and erosion is not a serious problem. See management subgroup 5B in table 9 for suitable management practices.

Rebuck silt loam (3-10% slopes) (R_A).—Throughout the agricultural uplands south of the North Branch of the Susquehanna River, this well-drained soil occupies mildly undulating to moderately rolling areas. It has developed on weathered pre-Wisconsin till and residuum derived from red, gray, and yellow shales and is associated with the well-drained shallow Leck Kill soils developed on similar materials.

The surface soil to depths of 6 to 8 inches is a brown silt loam containing some reddish-brown angular shale fragments that do not interfere with tillage. Below this layer is pale reddish-brown or moderate-brown friable silty clay loam that continues to a depth of 30 inches. Below 30 inches occurs pale reddish-brown to moderate-brown compact weathered pre-Wisconsin till. This till, when partly dry, breaks into small angular pieces along minute cleavage planes

and becomes a light yellowish brown. Dull reddish-brown and grayish-brown shale fragments are encountered in increasing numbers below 30 inches.

As in the Allenwood and Dewart soils, the subsoil and substratum of Rebeck silt loam are both very strongly to extremely acid. Roots, air, and moisture have no difficulty penetrating the subsoil or parent material.

Use and management.—At the time of the survey about 65 percent of Rebeck silt loam was in crops and vegetables, about 25 percent was in forest, and the rest was partly in pasture and partly idle. Crop yields are about equal to or slightly better than those on Allenwood silt loam and Allenwood gravelly silt loam. Because of its depth and ability to maintain good moisture conditions, this soil is superior to most of the other soils for apples, peaches, and other fruits. Its topographic position, however, is not everywhere favorable for these. Air drainage is poor in some places.

This is a desirable soil for crops and pasture. Special management requirements, which can be attained without difficulty, center about supplying lime and major plant nutrients, maintaining or increasing the supply of humus, and use of proper crop rotations. The soil must be supplied with phosphorous and potassium for high yields of most crops. Additional information on management is given under subgroup 1B in table 5.

Rebeck silt loam, eroded phase (3–10% slopes) (Rb).—Except for its greater losses through erosion, this phase is similar to Rebeck silt loam. From one-fourth to practically all of the original surface soil has been lost. Shallow gullies, generally more than 100 feet apart but occasionally 50 to 100 feet apart, have formed in all fields (pl. 3, B).

Use and management.—At the time of the survey all of Rebeck silt loam, eroded phase, had been cleared and, except for a few small patches that were in pasture, was being used for crops and vegetables. Crops yield about the same or 5 percent less than they do on Rebeck silt loam. Somewhat more care is needed to control erosion on this phase than on Rebeck silt loam. Among the many important practices of management that need attention are proper choice and rotation of crops; the growing of more legumes, especially clovers and alfalfa; the return of organic matter to the soil; contour tillage; strip-cropping where practical; and the judicious use of soil amendments. This soil is in management subgroup 1B of table 5.

Riverwash (coal screenings) (0–3% slopes) (Rc).—This land type consists of 1 to 3 feet or more of almost black fine coal material (culm) over alluvial soil material. This culm was washed from the culm dumps by streams and deposited along the lowland. The wash has ruined the land for agriculture, although deep-rooted trees still thrive where it is less than 3 feet deep. Many areas are bare of vegetation. Most of this land type is located along Shamokin Creek and the Susquehanna River. A considerable quantity of this material is being dredged out for fuel.

Rough stony land (Dekalb soil material) (3–60+ % slopes) (Rd).—This land type occurs on stony ridges and steep or precipitous mountain slopes, where little soil accumulation has taken place. The

Dekalb soils that occur on these areas are well-drained shallow soils that have developed on material residual from acid gray sandstone.

Rock outcrops or ledges of gray sandstone are common along the steep slopes, and they form a part of the ridge crests. On the wider ridges the soil material is deeper and the proportion of stones is less. In such places the surface soil is a light yellow, brown, or grayish-yellow stony sandy loam or stony loam. The finer surface roots bind the topmost 2- or 3-inch layer of black humus soil into a mat that is distinct from the rest of the upper layers. The subsoil consists of light yellowish-brown loose friable loam containing many pieces of gray sandstone and a few of conglomerate. The underlying material, at depths of 24 to 30 inches, is largely a mass of stones and rocks with some sandy light yellowish-brown soil material in the crevices.

As a whole, both the soil and the parent geological material are extremely acid. The soil material is low in organic matter and plant nutrients and is droughty.

Use and management.—This land is nonagricultural. It would be impossible to till and would have extremely low value for grazing if cleared. On some steep slopes, the stony soil material is so thin and patchy that it hardly covers the rock. This material supports a scattered growth of bushes and trees. On the broader divides and lower slopes the soil material is deeper and supports a fair growth of timber. This miscellaneous land type is listed with the soils of management group 9 in table 13.

Rough stony land (Weikert soil material) (70+ % slopes) (R_E).—Steep, precipitous, and extremely rocky glaciated slopes, ranging from 70 percent to virtually perpendicular, are occupied by this land type. Most of it occurs as bluffs on the south side of the North Branch of the Susquehanna River. The rocks—fine grained sandstones and shales—are mostly massive and tightly bedded; the soil between them is Weikert loam. This material supports a very scrubby and scattered growth of pines, oaks, and cedars that have obtained foothold in the crevices. This land type is listed with the soils of management group 9 in table 13.

Rushtown shaly silt loam (3–12% slopes) (R_F).—This soil occupies undulating to rolling areas in some of the valleys. Its total area is small. The parent material is either of alluvial or colluvial origin, but the precise manner of deposition is not known. Erosion is slight to moderate; from one-fourth to three-fourths of the original surface layer has been lost from cleared areas, and some shallow and deep gullies occur. Relief is smooth enough for the operation of all farm machinery without undue difficulties.

In cultivated fields the moist surface soil is dark yellowish-brown shaly silt loam that becomes lighter colored on drying. To a depth of 7 or 8 inches this material is soft, loose, and easily tilled. The subsoil is yellowish brown to brown friable shaly silt loam. Numerous small fragments or particles of shale stick together in a soft mass but offer little resistance to a spade. Below 30 inches the material is slightly compact; it consists of water-worn fine shale particles, $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, with some silty soil material in the interstices. Owing to the large proportion of shale particles throughout, the soil has poor moisture-retaining qualities. It is well aerated, however,

and can be penetrated by plant roots to a considerable depth. All the layers are strongly to very strongly acid.

Use and management.—At the time of the survey about 70 percent of Rushtown shaly silt loam was in crops; 15 percent was in forest; 10 percent was idle; and a few small patches were in permanent pasture. Crops are damaged during prolonged dry weather. Grasses, clover, and corn require frequent rains if they are to make vigorous and continued growth. Oats, soybeans, and buckwheat thrive better than most crops. Application of lime in the crop rotation is essential for success with legumes. Erosion control is not difficult if crops are properly chosen and rotated and contour tillage is practiced. Additional suggestions are given under management subgroup 3B in table 7.

Rushtown shaly silt loam, eroded rolling phase (12–25% slopes) (Rg).—Although much the same as Rushtown shaly silt loam, this phase occupies steeper slopes and in cleared areas has lost more than half its original surface soil and part of its subsoil through erosion. Shallow and deep gullies, usually more than 100 feet apart, are characteristic of many cultivated fields.

Use and management.—At the time of survey about 95 percent of this soil was cleared and in crops, principally corn, oats, wheat, mixed hay, and soybeans. Yields range from 5 to 10 percent below those obtained on Rushtown shaly silt loam.

This soil is not well suited to intertilled crops, but they can be grown safely if good management is followed. The crop rotation, however, would need to include close-growing legumes and grasses, and an intertilled crop should not be planted more often than once in 3 years. Lime and complete fertilizer are necessary for successful growth of most crops. When row crops are grown, contour tillage and strip cropping should be practiced. This soil is grouped with the soils of management subgroup 4B in table 8.

Ryder silt loam (3–8% slopes) (R_H).—This well-drained deep soil occurs on low broad ridges; it has developed on residuum and pre-Wisconsin till derived principally from interbedded gray shale and limestone.

The 6- to 8-inch surface soil consists of dark-brown mellow silt loam. The subsoil, to depths of about 24 inches, is a weak reddish-brown to moderate-brown firm silty clay loam. This is underlain in most places at depths of 30 to 48 inches by a pale-olive to olive-gray heavy firm talclike silty clay with a blocky structure. In some places the reddish-brown color of the subsoil continues into the substratum and is splotted with olive gray. Bedded dark-gray and black shale and limestone are encountered at 30 to 48 inches. Some fragments of shaly limestone and dark-brown shale are mixed with the subsoil.

The surface soil and upper subsoil are moderately acid and leached of most of the soluble plant nutrients. The lower subsoil is neutral to calcareous, however, and this characteristic is favorable to the growth of legumes. This soil has a fair amount of organic matter and other plant nutrients but is not quite so fertile as the soils underlain by and derived almost entirely from limestone. It has a good storage capacity for water and is permeable to roots, air, and moisture.

Use and management.—Practically all of Ryder silt loam has been cleared and is well adapted to all of the crops grown in the area. Vegetables do not mature early but generally return large yields.

This is one of the better soils of the upland for the production of crops or pasture. It is well suited to all the common crops and especially well suited to alfalfa and deep-rooted legumes. It is moderate to high in most plant nutrients, but responds well to use of some fertilizer because of its favorable moisture conditions. See subgroup 1A in table 5 for suggestions on management.

Schuylkill silt loam (0-3% slopes) (Sa).—This soil consists of fine coal screenings (culm) and alluvial soil material. The culm is generally in the upper 2-foot layer, which is mixed black and brown. The underlying material is variable, but in most places it is like that underlying the Huntington, Lindside, Tioga, or Middlebury soils. In most areas the soil has developed under imperfect drainage conditions. The water from the hard-coal regions is very acid because it is polluted by drainage from the mine workings; some of this acidity is passed on to areas of the soil subjected to overflow. Materials carried in solution by the polluted streams may have a detrimental effect on plant roots and plant and soil micro-organisms.

Use and management.—Probably 90 percent of this silt loam was in forest at the time of survey. Most of the rest was idle or abandoned. A few patches are cropped, but yields are low. Forest growth is good, though it apparently has been reduced to some extent by the deposition of coal screenings, or culm, and of materials carried in solution. This soil is in management group 7.

Sciotoville sandy loam (0-3% slopes) (Sb).—Like Sciotoville silt loam, this soil occurs on river terraces. The relief is almost level to undulating.

The 8- to 10-inch surface soil consists of grayish-brown porous sandy loam to loam. Weak yellow to light yellowish-brown mellow loam occurs between 10 and 18 inches. This layer of mellow loam is underlain by mottled yellowish-brown and gray sticky sandy clay. The lower subsoil varies in color and texture but is slowly pervious and wet during most of the year. Some water-worn gravel is mixed with the sand and silt of the substratum. The organic-matter content of this soil is moderate, erosion is only slight, and tilth conditions are favorable.

Use and management.—Sciotoville sandy loam has limited suitability for some crops because it is sandy, has poor underdrainage, and has developed from materials low in plant nutrients. At the time of survey about 85 percent of it was used for crops, roughly 5 percent was in pasture, 5 percent was in forest, and the rest was idle or used as town property. General crops, soybeans, and vegetables are grown. Yields are about 25 percent less than on Wheeling sandy loam, and crops are more adversely affected by drought or excessive rainfall. Corn, oats, or soybeans are better suited than wheat, barley, or hay. Alfalfa is not grown, as it is not adapted to this soil. The same amendments are advisable for this soil as for Sciotoville silt loam. This soil is listed with those of management subgroup 5B in table 9.

Sciotoville silt loam (0-3% slopes) (Sc).—This moderately well drained soil occupies almost level to gently undulating areas on river terraces in both counties. It is associated with the well-drained Wheeling, the poorly drained Ginat, and the very poorly drained Chilo soils, all of which have developed on similar parent materials.

The surface soil, extending to depths of 7 to 8 inches, is grayish-brown friable silt loam. Below this and continuing to depths of 14 to 20 inches is weak-yellow to light yellowish-brown silt loam. The lower subsoil is a mottled gray, yellow, and brown slightly compact but friable silty clay loam. Silt and fine sand, similar to those underlying the Wheeling loam but somewhat finer textured, occur below depths of 36 to 40 inches.

Like the other soils of the river terraces, this soil is very strongly acid throughout. Erosion is slight, the organic-matter supply is moderate, and tilth conditions are good. Surface drainage is fair, but internal drainage is impeded.

Use and management.—At the time of the survey crops were grown on about 85 percent of Sciotoville silt loam. About 7 percent was in forest, 5 percent was in pasture grasses, and the rest was idle. Crops yield 10 to 30 percent less than on Wheeling loam; the difference in yield depends on the kind of crop grown and its suitability to the respective soils. Sciotoville silt loam is not suited to alfalfa, fruit trees, or other deep-rooted crops. Red clover freezes out to a considerable extent.

Deep drainage ditches would make this soil suitable for a wider variety of crops and increase the yields of most crops. Nevertheless, elaborate artificial drainage systems probably would not be profitable for general crops.

The soil is suited to intensive cropping but needs lime and complete fertilizer if it is to maintain yields at a high level. It is deficient in nitrogen, phosphorus, and potassium for most crops. Suitable uses of this soil are given under management subgroup 5B in table 9.

Sedan cherty silt loam (3–8% slopes) (Sd).—This well-drained deep soil of mild hummocky relief has developed on weathered pre-Wisconsin till derived from gray cherty limestone, sandstone, and quartzite. It occurs in valleys on the lower slopes of the cherty limestone ridges.

In cultivated fields the 4- to 8-inch surface soil is brown friable cherty silt loam. The upper subsoil, a yellowish-brown friable loam to silt loam, grades into reddish-brown friable moderately firm clay loam at a depth of 20 inches. Below depths of 30 to 36 inches is light reddish-brown or yellowish-brown slightly compact clay loam till of moderately well developed blocky structure. Some gray mottlings occur in the weathered parent material in low areas. Black flakes (probably manganese) are common on the surface of the aggregates in the lower layers. Angular chert fragments and, in some places, a few rounded pieces of shale gravel are characteristic of all of the soil layers. These are not numerous enough to interfere with tillage; they probably increase the porosity of the soil. In a few places black Marcellus shale underlies this soil at 40 inches or more, and here the subsoil is heavier because of the influence of this fine-textured shale.

According to field tests, Sedan cherty silt loam is strongly acid in the upper layers and moderately acid in the lower subsoil and parent material. In content of organic matter and plant nutrients, type of parent material, and many other ways, this soil is similar to Kreamer cherty silt loam, eroded phase. The soil layers, however, contain more coarse materials and are less compact; permeability and oxidation are therefore increased. Runoff is less than on the eroded phase of

Kreamer cherty silt loam, and more than half of the original surface soil still remains, despite the fact that a large part of the soil has been used for growing grains. Both surface soil and subsoil drainage are good except in small spots where seepage water prevents normal drying after long rains.

Use and management.—At the time of the survey at least 95 percent of Sedan cherty silt loam was being used for the crops commonly grown in this section. The rest was in pasture grasses. Crop yields are good to very good, the yield depending on the amount of fertilizer, lime, and manure used. Wheat and timothy do not thrive so well as on heavier soils.

This is a desirable soil for most crops grown in these counties. It is productive, easy to work, and not difficult to protect from erosion. It needs lime and phosphate, nitrogen, and potash fertilizer for maximum production of most crops. If the crops are properly fertilized, production can be maintained under a rotation of the kind suggested under management subgroup 1A of table 5.

Sedan cherty silt loam, eroded phase (3–8% slopes) (Se).—This soil is similar to Sedan cherty silt loam, but slightly more of its surface soil has been lost, and shallow and deep gullies have formed in most fields. These gullies are usually more than 100 feet apart and offer no serious handicap to tillage.

Use and management.—Practically all of this soil was under cultivation at the time of the survey. Crop yields average nearly the same as on Sedan cherty silt loam to 10 percent less. Since the soil occupies mild slopes, erosion can be prevented by simple practices such as contour tillage and strip cropping, or terracing where feasible. Because it is eroded, this soil needs more careful management than Sedan cherty silt loam. This management, however, is not difficult to accomplish. See subgroup 1A of table 5 for rotations suitable. The lime and fertilizer requirements of this soil are the same as those for Sedan cherty silt loam.

Sedan cherty silt loam, eroded rolling phase (8–20% slopes) (Sf).—As a result of its steeper slopes, this phase has slightly thinner surface soil and less organic matter than Sedan cherty silt loam. It has lost one-fourth to three-fourths of its original surface soil, and shallow gullies have formed in most of the fields. In a few fields deep gullies have been cut into the subsoil.

Use and management.—At the time of the survey practically all of this eroded rolling phase had been cleared and was being used for general crops, soybeans, and alfalfa. Yields are 5 to 10 percent less than on Sedan cherty silt loam because of greater runoff and lower nitrogen content. This soil is harder to manage than Sedan cherty silt loam. Contour tillage, strip cropping, and decreased use of clean-tilled crops would help check erosion. Rotations should consist largely of close-growing legumes and grasses. Lime and complete fertilizer are necessary. Additional management suggestions are given under subgroup 2A in table 6.

Sedan gravelly silt loam, eroded phase (3–8% slopes) (Sg).—This soil is similar to Dewart gravelly silt loam except for containing more limestone fragments and being moderately eroded. It occurs on undulating areas from which nearly half the original surface soil

has been removed by erosion. Scattered shallow gullies have formed in all fields.

The 4- to 6-inch surface soil consists of dark-brown friable mellow loam to silt loam. This is underlain by 4 to 6 inches of strong-brown friable fine sandy clay. From a depth of about 12 inches down to 32 inches there is a moderate reddish-brown friable moderately developed clay loam of crumb structure. The weathered parent material below 3 feet consists of pale reddish-brown firm but friable clay loam till that shows splotches of yellow. Some rounded pieces of gravel derived from sandstone, shale, and limestone occur throughout all layers and the substratum but do not interfere with tillage.

The soil is strongly to medium acid. Below 5 to 6 feet, however, leaching is not so intensive and the material is less acid. The supply of organic matter is moderate.

Use and management.—Mild surface relief, accompanied by good internal drainage, has tended to hold down erosion losses on Sedan gravelly silt loam, eroded phase. All of it has been cleared and is used regularly for crops. General farm crops, alfalfa, soybeans, potatoes, and tomatoes are grown extensively. Soil conditions are slightly more favorable for deep-rooted than for shallow-rooted crops.

This soil is well suited to practically all crops grown in this section. It has good tilth and adequate water-holding capacity. High yields of most crops are possible when lime, nitrogen, phosphate, and potash are wisely used. A rotation of moderate length that includes a deep-rooted legume or a legume-grass mixture should keep this soil in good physical condition. Where row crops are grown frequently, cover crops and farm manure would aid in maintaining a satisfactory supply of humus. This soil is in management subgroup 1A of table 5.

Senecaville silt loam (0-3% slopes) (SH).—This is an imperfectly drained reddish soil occurring on streams that drain those areas of the two counties underlain by red shale and sandstone. Except for small areas at the heads of drains, it is subject to overflow nearly every year. The areas at the heads of drains receive seepage water and some soil material from surrounding soils.

The surface soil—12 to 16 inches of weak-red to dark reddish-brown friable heavy silt loam—has a high organic-matter content because soil materials are periodically deposited on it. Mottled weak reddish-brown, dull-gray, and dark-brown slightly plastic silty clay loam occurs between depths 14 and 30 inches. Some organic matter is distributed throughout this layer. Below 30 inches occurs mottled gray, brown, and yellowish-brown heavy plastic silty clay loam. A few small red shale fragments are scattered through the soil layers. The lower subsoil is saturated most of the year because of the high water table and the position of the soil in relation to the higher lying upland soils.

Included with this soil are some small areas, mostly on Mahantango Creek, that are well drained to depths of 36 inches or more. Owing to the better drainage, the subsoil in these areas is more reddish brown between depths of 18 and 36 inches than the typical soil. These included areas are largely used for general crops and yield about 10 percent more than the typical soil.

Use and management.—At the time of the survey approximately 65 percent of Senecaville silt loam was in crops, 15 percent in pasture,

and 15 percent in forest. About 5 percent was idle. Corn and hay are the principal crops, although some oats, wheat, and soybeans are grown on the higher lying areas. Since most of the soil is only moderately acid, lime is not recommended for pasture or for field crops other than legumes.

This soil is suited to rather intensive use for crops, but choice of crops is restricted by its imperfect drainage and susceptibility to flooding. Corn and the annual summer hay crops are well suited, but alfalfa is poorly suited. Small grains are generally more susceptible to lodging and disease and mature later than on soils that are well drained. Under continuous cropping, fair yields are obtained with only limited soil treatment. Moderate applications of phosphate and potash fertilizer are required for high yields of most crops. See management subgroup 6B in table 10 for suitable rotations.

Shelmadine silt loam (0-6% slopes) (Sk).—This soil occupies poorly drained low areas in the valleys of the two counties. The parent material is mostly till, but in places it is of colluvial origin. Most of the soil occurs in association with the imperfectly drained Alvira soil, which developed from similar materials.

The 6- to 10-inch surface layer consists of dark-gray or medium-gray plastic heavy silt loam. In a few places, owing to the large content of decayed vegetable matter, this layer is darker than typical and is almost black when moist. Underlying the surface layer and continuing to depths of 30 to 36 inches is mottled yellowish-brown and gray sticky slightly plastic silty clay loam or silty clay. Below 36 inches the material is slightly lighter in texture and more friable, but it is somewhat compact. A few shale and sandstone fragments of gravel size are mixed with the soil material. They interfere with cultivation in only a few places, which are shown on the map by symbol.

The soil and parent material are very strongly to extremely acid. The poor drainage results chiefly from topographic position. The firm fine-textured subsoil, although not completely impervious, allows very slow movement of water both laterally and vertically.

Use and management.—At the time of the survey probably 50 percent of this soil was used for crops most of the time. About 15 percent was idle, 5 percent was in pasture, and 30 percent had never been cleared. Corn, oats, soybeans, and mixed clover and timothy are widely grown. Pastures consist mainly of coarse grasses and weeds. Idle fields support a cover of alders, coarse grasses, and wet-land weeds. Crop yields are usually low because of poor drainage. Some buckwheat is sown; like soybeans, it is sometimes planted on land that remained wet too late in spring for planting corn. Pasture grasses, alsike clover, oats, and timothy are best adapted. Red clover freezes out badly and cannot root deep enough to insure a fair crop. Corn drowns out on many of the wetter spots.

This soil could be improved considerably by digging open ditches. The ditches would remove surface water and lower the ground water level enough to allow deeper rooting of tame grasses and crops. Better grazing and some increase in crop yields would result. Erosion control is not a problem, and in most places the surface soil contains a good supply of organic matter. Fertilizers that contain little or no nitrogen but a fairly large proportion of phosphorous and

potash are recommended for crops. Manure and lime are also needed. This soil is in subgroup 5C of table 9.

Springtown stony loam (5-20% slopes) (Sl).—Long narrow strips of this well-drained soil occur in strips at the bases of lower mountain slopes in the southern half of Northumberland County. These strips separate the reddish-brown Norton soils on the lower slopes from the gray soils on the steeper mountain slopes. The soil has developed from a colluvial material brought down from the mountainsides and combined with pre-Wisconsin glacial till derived from a mixture of red shale, gray sandstone, and quartzite.

The surface soil extends to depths of 7 to 10 inches; it is a light brownish-gray loose stony loam. In wooded areas the topmost 2 inches of it is stained almost black by a small quantity of organic matter. Stones are so numerous that tillage is exceedingly difficult in many places. The upper subsoil is a yellowish-brown friable weakly platy loam or sandy clay. This is replaced at depths of 20 to 24 inches by pale reddish-brown to strong-brown very firm weakly platy clay loam. The underlying till, at depths of 36 to 49 inches, is firm, moderately hard when dry, and predominantly pale red profusely splotched with yellow. Stones and angular shale fragments occur throughout this soil in Northumberland County. The reddish color in the lower subsoil and substratum is caused largely by material weathered from the red shale that underlies the soil at depths of 4 to 10 feet.

All horizons are very strongly acid. Field observations indicate a lower plant-nutrient content than that of most of the other deep soils in the glaciated areas. Although the soil varies in stoniness, depth, thickness of the various layers, and occurrence of seepage spots, its moisture-holding properties are generally good. Tree roots readily penetrate to the underlying glacial till.

Use and management.—Low natural fertility and difficulty of cultivation account for the fact that no more than 20 percent of Springtown stony loam had been cleared at the time of survey. Much of the land once cleared had been abandoned. The remaining cultivated areas are largely in corn and hay. Shallow-rooted plants such as bluegrass and alsike clover return low yields unless fertilizer and lime are used liberally. This soil is too steep for cultivation and is best suited to pasture or forest, as shown in management subgroup 8B of table 12.

Springtown stony loam, hill phase (20-35% slopes) (Sm).—All of this soil occurs near the base of mountain slopes in the southern part of Northumberland County. It is essentially like Springtown stony loam except that the single slopes are steeper. The few small cleared spots have been moderately sheet eroded, and gullying is common in unprotected places.

Use and management.—This soil is best adapted to forest. At the time of survey about 80 percent was forested, a small part was idle, and the rest was used for corn and hay. Steepness of slope, plus the high content of sand and stones and the low content of organic matter in the upper layers, makes this soil unsuitable for pasture grasses and crops. The soil is also relatively low in plant nutrients, including lime, phosphorus, nitrogen, and potassium. It is listed in management group 9 in table 13.

Stephensburg shaly silt loam (3-12% slopes) (Sn).—This well-drained moderately deep soil has developed an undulating to moderately rolling areas. The parent material is weathered pre-Wisconsin till and residuum derived principally from thin, platy, dark Marcellus shale. The soil is associated with the well-drained shallow Kistler and imperfectly drained Comly soils, which developed from similar parent material. In most cultivated and idle fields from one-fourth to three-fourths of the original surface soil has been lost through erosion.

Under forest cover, Stephensburg shaly silt loam has a 6- to 8-inch surface layer of light-brown silt loam. The topmost 2 inches is stained dark with partially decomposed organic matter. The subsoil is strongly acid yellowish-brown friable silt loam or silty clay loam that extends to depths of 20 to 30 inches. It rests on acid, thin, platy dark shale. The quantity of shale chips in the soil increases with depth. Here and there rounded fragments of sandstone and shale are mixed with the soil material. Relatively impermeable shale bedrock occurs within 3 feet of the surface and makes the soil susceptible to erosion.

As compared with the soils developed from limestone and highly calcareous shale materials, this soil is inherently low in lime, organic matter, and other plant nutrients.

Use and management.—Like the Kistler soils, Stephensburg shaly silt loam is too shallow to be classed as a First- or Second-class soil. It is, however, adapted to a wide range of crops and has very good workability (pl. 5, C). At the time of the survey about 40 percent was in general crops, soybeans, and vegetables, 10 percent was idle, 5 percent was in permanent pasture, and the rest was in forest. Crop yields are 10 to 20 percent higher than on the shallower Kistler soils with similar slopes. Good management would include practices to increase the content of humus and nitrogen, as well as the use of lime, phosphorus, and probably potash in a good rotation. For specific examples of suitable rotations see management subgroup 1B of table 5.

Stephensburg shaly silt loam, eroded hilly phase (20-35% slopes) (So).—Steeper slopes and greater degree of erosion differentiate this soil from Stephensburg shaly silt loam. Cleared areas are moderately to severely eroded. One-half to all of the original surface soil has been lost, as well as part of the original subsoil in half of the cleared areas. Shallow gullies occur in all fields, and deep gullies in about one-fourth of them. The gullying and the loss of organic matter and a considerable part of the upper soil layers have considerably impaired tilth and lowered the water-holding capacity.

Use and management.—At the time of the survey about 85 percent of this eroded hilly phase was in crops, nearly 10 percent was idle or abandoned, and 5 percent had been sown to pasture grasses. Corn, hay, oats, and wheat are grown.

Economical control of erosion is not possible on this soil where cultivated crops are grown. The cleared areas should be retired to permanent pasture or used only for hay crops. Overgrazing should be avoided. Reforestation, where in accordance with farm-management plans, is advisable for severely eroded areas. Lime and phosphate fertilizer are essential for establishing and maintaining good pasture grasses. Also, some benefit from use of potash on pastures can be expected. This soil is in management subgroup 8B in table 12.

Stephensburg shaly silt loam, eroded phase (3–12% slopes) (SP).—Shallow gullies distinguish this phase from Stephensburg shaly silt loam; they are more than 100 feet apart in most places but considerably more closely spaced in a few fields. In places small channels have been carved into the subsoil. The surface soil of this phase is not so deep as that of Stephensburg shaly silt loam, and the content of organic matter is slightly less. Tilth has also become impaired, and shale fragments are more abundant in the upper layers.

Use and management.—At the time of the survey nearly 85 percent of this eroded phase was used for crops (pl. 5, B), and about 15 percent was in pasture or idle. Crop yields are nearly the same as or about 5 percent lower than on Stephensburg shaly silt loam. Erosion can be controlled by simple practices, as the slopes are mild. Strip cropping and contour tillage are practiced in many fields. Requirements for good management are relatively simple—chiefly proper selection and rotation of crops and use of lime and fertilizer. The soil is suited to all crops grown in this section, and erosion can be prevented by the use of moderate to long rotations that include a legume or legume-grass mixture at least 50 percent of the time. Suitable rotations are given under management subgroup 1B in table 5.

Stephensburg shaly silt loam, eroded rolling phase (12–20% slopes) (SR).—Except for greater relief (pl. 5, A), this soil is very similar to Stephensburg shaly silt loam. Its agricultural value is less, however, because the more rolling relief causes greater difficulty in tillage and more loss of organic matter and soil material through erosion. In cleared areas about three-fourths of this soil is moderately eroded, and one-fourth is severely eroded, having lost a significant part of the subsoil.

Use and management.—At the time of the survey approximately 90 percent of this eroded phase had been cleared. Of this area, about 10 percent was in pasture, 10 percent was idle, and the rest was used for crops. Yields are 5 to 10 percent less than on Stephensburg shaly silt loam. Good management should prevent further erosion, improve the physical condition of the soil, and improve moisture relations. The application of phosphate, some potash, and lime is also required. Sod-forming grasses and legumes such as alfalfa and red clover should be grown during much of the rotation; they are effective both in controlling runoff and in increasing the content of organic matter and nitrogen. Contour tillage should be practiced, and strip cropping may be practicable where row crops are grown on the longer slopes. Suitable rotations are shown under management subgroup 2B of table 6.

Tioga sandy loam (0–3% slopes) (TA).—This sandy loam is differentiated from Tioga silt loam on the basis of texture; otherwise the two are much alike. The relationship between them is the same as that between the two Huntington soils. This sandy soil is restricted mostly to the bottoms on the North Branch of the Susquehanna River; it generally occurs close to the river bank where the deposition of sand is greater during overflow. The soil usually is overflowed more frequently than Tioga silt loam, but the overflow does little damage because fall-sown crops ordinarily are not grown.

This sandy loam has a weak-brown porous sandy loam surface soil, 8 to 16 inches thick. Below this is brown or yellowish-brown friable loam to sandy clay.

The supply of organic matter and other plant nutrients is moderate to high, and the acidity ranges from strong to moderate in most places. This soil does not store as much water for plants as the finer textured Tioga silt loam, but is not considered droughty. Generally there is abundant movement of capillary water near the stream courses.

Use and management.—Most of Tioga sandy loam is used for corn and hay. Yields are about 5 to 10 percent lower than those ordinarily obtained on Tioga silt loam. Additions of small amounts of lime, phosphorous, and potash benefit crops on this soil. Most crops grown in the area are suitable for this soil. Exceptions are alfalfa and fall-sown grains, which cannot withstand the frequent overflows. This soil is in management subgroup 6A of table 10.

Tioga silt loam (0–3% slopes) (Tb).—This well-drained soil occurs on the bottom lands in the two counties. It has developed on deep silty deposits that have sufficient local elevation to insure good drainage and effective aeration to a depth of 3 or more feet. Most of the soil is subjected to occasional overflows of short duration that normally come in spring before the crops are planted. Most areas on Shamokin Creek are seldom, if ever, overflowed. A few on the North Branch of the Susquehanna River are overflowed about once every 10 to 15 years.

The soil was derived from parent material washed from areas underlain principally by acid gray sandstone and shale. It is associated with the imperfectly drained Middlebury and the poorly drained Holly soils, which developed from similar materials.

The surface soil is weak-brown to moderate-brown very friable silt loam, 8 to 12 inches deep. The subsoil is a moderate yellowish-brown silt loam to silty clay loam, friable when broken out but firm in places. In most places the subsoil has a reddish color that indicates considerable oxidation. Below 30 inches the material becomes lighter in color; also, the proportion of fine sand increases, thus insuring excellent drainage. All conditions are favorable for drought resistance, yet there is not the waterlogging during wet weather that marks areas of the associated imperfectly drained Middlebury silt loam.

This soil is moderately to strongly acid and moderately high in organic matter and most plant nutrients. Because it is not subjected to prolonged overflows, not much fresh sediment is added to the soil. In many respects, this soil is similar to Huntington silt loam on the West Branch of the Susquehanna River; it differs particularly in being more acid throughout.

Use and management.—Practically all of Tioga silt loam has been cleared, and except for areas in towns it is used to produce crops. Corn, oats, wheat, mixed hay, alfalfa, and soybeans are widely grown. This is an excellent vegetable soil. Barring the possibility of damage from overflows, it is adapted to wheat, clover, and alfalfa, as well as to many crops planted in spring.

This soil responds well to manure, phosphate, and potash. No extra nitrogen is needed if manure is used regularly, but a small amount of lime is essential for success with legumes. In general, the soil receives no special practices for preventing erosion and conserving moisture.

In places along some streams, however, it may be necessary to build check dams to prevent bank cutting. Suitable crop rotations are given under management subgroup 6A in table 10.

Trexler channery loam (3-12% slopes) (Tc).—This soil has sandstone bedrock closer to the surface (generally at 10 to 24 inches) and a texture not so heavy as that of Trexler channery silt loam. It occupies ridges and smooth undulating areas in the agricultural sections of Northumberland County. The dominant slope range is 3 to 12 percent, but a few areas with slopes ranging up to 25 percent are included.

The surface soil is pale-brown porous friable loam to silt loam, 6 to 8 inches thick. Many brown fine-grained sandstone fragments 2 to 5 inches in diameter are scattered throughout this layer. Between depths of 8 and 16 inches is light reddish-brown friable loam to silt loam that contains numerous brownish sandstone fragments. These fragments increase with depth, and at about 16 to 24 inches bedded fine-grained sandstone formations are encountered. This soil varies in depth to bedrock and in the content of sandstone in the upper layers. Bedrock crops out in a few places.

Both the soil and parent material are extremely acid; the supply of plant nutrients is low. The soil is porous throughout and has low water-holding capacity.

Use and management.—At the time of the survey an estimated 60 percent of Trexler channery loam was forested. Nearly 35 percent was being used for crops, and about 5 percent was idle or abandoned. The soil is adapted to about the same crops as Weikert channery silt loam, though the Weikert is more suitable for small grains. Erosion is slight in cleared areas and can be controlled by proper choice of crops, use of winter cover crops, and addition of necessary treatments—lime, phosphate and potash fertilizer, and humus. Rotations should include a legume, which will maintain or increase the humus supply. The channers are numerous enough to interfere to some extent with tillage but do not limit the choice of crops. Suitable practices are shown under management subgroup 3B in table 7.

Trexler channery loam, eroded phase (3-12% slopes) (Te).—This phase has thinner surface soil and more numerous gullies than Trexler channery loam. From one-half to nearly all of the original surface soil has been lost. Shallow gullies have formed throughout the area, and a few deep ones have cut down to bedrock.

Use and management.—Practically all of this soil has been cleared. Crops yield about 5 percent less than on Trexler channery loam. Where row crops are grown, it is necessary to control erosion by use of strip cropping on the longer slopes, sodding of watercourses, and contour tillage. The soil is low in all plant nutrients; lime and complete fertilizer are essential for maintaining soil fertility and productivity. This soil is in management subgroup 3B, as shown in table 7.

Trexler channery loam, steep phase (20-50% slopes) (Tr).—This phase is distinguished from Trexler channery loam by its steeper slopes. Shallow depth and low inherent fertility make it very low in productivity. Nearly all of the soil is in forest. Although the timber is stunted and grows slowly, it gives better returns than would

pasture. A few patches have been cleared and are being used for hay and pasture. Because row crops have seldom been grown, erosion is only slight. This soil is classed with the rough stony and very steep land of management group 9 in table 13.

Trexler channery silt loam (3-12% slopes) (Tg).—This well-drained deep soil is not extensive. It has developed from weathered pre-Wisconsin till and residuum derived principally from acid yellowish sandstone. Erosion is only slight to moderate, and there are practically no gullies. From one-fourth to three-fourths of the original surface soil has been lost from cleared areas. This soil differs from Allenwood gravelly silt loam primarily in having a lighter textured subsoil and more sandstone fragments.

In the virgin state, the 6- to 8-inch surface soil is grayish brown loose channery loam to channery silt loam, stained dark with organic matter in the topmost 2 inches. The subsoil is friable sandy clay with a soft granular structure; it is strong brown to yellowish brown, or yellowish brown with a reddish cast. Numerous yellow to yellowish-brown sandstone and shale fragments are mixed with the soil material but are not large enough to interfere with tillage. These fragments become more numerous in the underlying pre-Wisconsin till. Bedrock is encountered at depths of 3 to 5 feet in most places.

The soil is probably lower in humus and lime and other mineral plant nutrients than the Allenwood and Rebeck soils. It is extremely acid in the subsoil and parent material. Surface drainage is good.

Use and management.—At the time of the survey about 55 percent of Trexler channery silt loam was used for crops, 40 percent was in forest, 2 percent was in pasture, and 3 percent was idle. Among the native trees are red, white, black, and chestnut oaks, maple, and beech. Staple field crops such as corn, oats, wheat, hay, and soybeans are grown. Yields are only fair, unless large quantities of fertilizer and lime are used. Corn, oats, and soybeans are better adapted than wheat, alfalfa, clover, or shallow-rooted crops.

Applications of lime, phosphate, potash, and manure are essential for successful growth of crops. The soil responds to frequent applications of fertilizers and is well adapted to vegetables if the organic-matter supply is built up. Specific management practices are given under subgroup 1B in table 5.

Trexler channery silt loam, eroded hilly phase (20-25% slopes) (Th).—Except for its stronger slopes and greater depth of erosion, this phase resembles Trexler channery silt loam. Erosion has been somewhat greater in most cleared areas than on the eroded rolling phase of Trexler channery silt loam, and gullies are more common. Several small areas with slopes greater than 35 percent and others on which erosion has not been particularly active are included.

Use and management.—At the time of the survey about 55 percent of this eroded hilly phase was being used for crops, about 30 percent was in forest, and 15 percent was idle. Crop yields are 30 to 40 percent below those obtained on Trexler channery silt loam because of greater loss of organic matter and increased runoff. Since runoff is rapid, the soil should be used, where practicable, only for forests or for pasture or hay crops such as clover, timothy, orchard grass, and other grasses. Liberal applications of lime, phosphate, and potash are

needed for crops or pasture. Additional management suggestions are given under subgroup 8B of table 12.

Trexler channery silt loam, eroded phase (3-12% slopes) (Tk).—This phase differs from Trexler channery silt loam in having lost more soil material through erosion. Shallow gullies have formed in all areas, and a few deep ones occur in poorly managed fields. The organic-matter supply is low in most places, and tilth has become less favorable as a result of erosion. The 2- to 4-inch surface soil is grayish-brown friable silt loam; the subsoil is strong brown to yellowish brown.

Nearly all of the soil is being used for crops. Yields are slightly lower than those on Trexler channery silt loam. A few small patches have been abandoned and are growing up to bushes and briars.

Use and management.—The natural productivity of this soil is moderately low, and average yields of crops are a little less than those obtained on Trexler channery silt loam. Special attention should be given to fertilization and liming to build up soil fertility. Row crops should be grown as infrequently as possible. They should be replaced by close-growing small grains, hay, and winter cover crops. This soil is in management subgroup 1B, as shown in table 5.

Trexler channery silt loam, eroded rolling phase (12-20% slopes) (Tl).—Except for its steeper slopes, degree of erosion, and greater loss of organic matter, this soil has the same appearance and characteristics as Trexler channery silt loam. From one-half to practically all of the original surface soil has been lost. Shallow gullies have formed in most of the fields and in a few places have cut trenches into the subsoil. Several small areas on similar topography but with a gravelly instead of a channery surface are included with this soil.

Use and management.—At the time of the survey practically all of this eroded rolling phase was cleared and more than 90 percent was used regularly for crops. About 10 percent was partly idle and partly in pasture. Crop yields are 15 to 20 percent lower than on Trexler channery silt loam, and the problems of soil management are more complex. A larger part of the soil should be kept in hay crops, which would replenish the organic-matter supply and protect the soil from additional erosion. Lime, phosphorus, and potash are needed for most crops. Runoff can be controlled and the content of organic matter and nitrogen increased by including legumes and grasses in a moderately long rotation. Intertilled crops should not be grown more than one year in the rotation. Specific management suggestions are given under subgroup 2B of table 6.

Trexler channery silt loam, rolling phase (12-20% slopes) (Tm).—This soil has steeper slopes than Trexler channery silt loam. Erosion is not serious at the present time. Less than half of the surface soil has been lost from the cleared areas, and only a few shallow gullies have formed.

Use and management.—At the time of survey 70 percent of this rolling phase was in forest, and probably 25 percent was used for crops. The rest was idle. This soil has about the same profile characteristics as Trexler channery silt loam and is used for the same crops. Yields, however, are lower on this phase and management

problems are greater. Contour plowing, strip cropping, and greater use of close-growing crops are necessary for erosion control.

Most of this soil is probably best suited to pasture, because of hilliness, somewhat shallow depth, and high susceptibility to erosion. Lime, phosphate, and possibly potash are the principal treatments needed to maintain desirable stands of pasture grasses and legumes. Nitrogen aids materially in establishing pastures. This soil is classed in management subgroup 2B, as shown in table 6.

Trexler gravelly silt loam (3-12% slopes) (T_N).—A more compact lower subsoil and a gravelly surface layer are the principal differences between this soil and Trexler channery silt loam. This soil also is slightly heavier textured throughout and contains more rounded fragments of sandstone and shale. Erosion has reduced the thickness of the original surface soil by 25 to 75 percent, and gullies are common in many fields. In places trenches have been cut into the subsoil and substratum.

The surface soil is 6 to 8 inches of pale-brown friable gravelly silt loam, which in most cultivated areas has been thinned by erosion to a thickness of 3 to 6 inches. The subsoil is light reddish-brown clay loam, moderately firm and somewhat compact in the lower part. It extends to depths of 30 to 36 inches, where it grades into pale reddish-brown to yellowish-brown firm slightly compact weathered glacial till and residuum of a clay loam texture. Some reddish and gray sandstone and shale fragments are mixed with the soil material but do not interfere with tillage.

The soil is extremely acid throughout and low in most plant nutrients. Tilth conditions are good. The organic matter supply has been reduced by erosion, and more effort should be made to replenish it by using legumes and manure.

Use and management.—The differences between Trexler gravelly silt loam and Trexler channery silt loam are not great. Crop adaptations and yields are nearly the same. At the time of the survey about 90 percent of this gravelly silt loam was used for crops, and 10 percent for forest. Most crops, including alfalfa, soybeans, and vegetables, are suitable; they produce moderate yields. Because this soil has more favorable moisture-holding capacity, wheat, hay crops, and pasture grasses do slightly better on it than on Trexler channery silt loam. Phosphate and lime, as well as greater supplies of organic matter and nitrogen, should be supplied regularly. Potash is also essential for high yields of most crops. Specific management suggestions are given under subgroup 1B in table 5.

Turbotville silt loam (1-6% slopes) (T_o).—This imperfectly drained soil has developed from weathered pre-Wisconsin till and residuum derived principally from grayish colored high grade limestone. Most of it occurs on lower slopes in association with the other soils derived from limestone materials. In most places one-fourth to one-half of the original surface soil has been lost, but no gullies have formed.

In cultivated fields the 4- to 8-inch surface layer is grayish brown or moderate-brown friable silt loam. The thickness of this layer depends on the degree of erosion. Extending to depths of 18 to 24 inches is the upper subsoil, a firm yellowish-brown silty clay loam or

silty clay of granular structure that is high in water-holding capacity and conducive to air and root penetration. The material beneath the upper subsoil is somewhat variable in color, but consistently heavy textured and slightly plastic. Splotches of gray are characteristically mixed with a dull-yellow base color.

The mild acidity in the upper layers and the neutral to slightly alkaline condition of the lower subsoil favor excellent growth of clover and pasture grasses. The content of organic matter and plant nutrients is relatively high. Nevertheless, the soil warms up late in the spring, and its moderately permeable lower subsoil restricts air, water, and root penetration significantly. This decreased absorption of water naturally increases runoff, but the mild relief has kept down erosion losses.

Use and management.—Probably over 95 percent of this soil was used for crops at the time of the survey. Most of the rest was in permanent pasture. Corn, oats, wheat, soybeans, mixed hay, and alfalfa, are grown on most of the land. A few small patches of potatoes and tomatoes are planted, but these crops are not grown so extensively as on the better drained soils to which they are better suited. Yields are about 5 to 10 percent lower than on Washington silt loam. Vegetables yield 20 to 30 percent less, the actual yield depending on rainfall, soil variations, and management.

Although its moisture conditions are not ideal, this soil is suited to intensive use because of its high fertility and gentle slopes. Management requirements are relatively simple. Short rotations that include a legume to maintain the humus content and physical condition of the soil are satisfactory. Phosphate and potash fertilizer are necessary to increase and maintain high yields. Tillage should be avoided when the soil is too wet. Additional management suggestions are given under subgroup 5A in table 9.

Turbotville silt loam, eroded gently rolling phase (6–12% slopes) (Tr).—Because of greater slopes, this phase is more eroded than Turbotville silt loam. The surface soil is consequently slightly thinner; one-fourth to three-fourths of it has been lost. Also, the organic-matter content is less in most places. A few shallow gullies form each year on most areas.

Use and management.—Practically all of this soil is used for crops. The crops adapted and the soil treatments required are much like those for Turbotville silt loam, but yields are 5 to 10 percent less because of greater runoff and lower nitrogen content. The stronger slopes make management practices more exacting than those for Turbotville silt loam. Requirements included are proper choice and rotation of crops, careful selection and use of soil treatments, and use of practices for controlling runoff and erosion. Intertilled crops should be grown less frequently than on Turbotville silt loam. Contour tillage should be practiced if at all feasible, and terracing may be practicable if row crops are grown frequently. This soil is in management subgroup 5A of table 9.

Turbotville silt loam, eroded phase (1–6% slopes) (Tr).—Except for difference in degree of erosion, this phase is similar to Turbotville silt loam. Shallow gullies more than 100 feet apart have formed, whereas no gullies were observed on Turbotville silt loam.

Use and management.—Crop yields on this eroded phase are equal to or only slightly less than on Turbotville silt loam. In the virgin state the upper layers of this soil are leached and moderately acid. Small amounts of lime are beneficial, especially for legume crops.

Good response is obtained from phosphate and possibly potash fertilizer. Nitrogen should be supplied largely by legumes and manure. Available supplies of potash and calcium seem to be higher in the eroded areas. See management subgroup 5A of table 9 for additional suggestions.

Warrior gravelly silt loam (3–8% slopes) (W).—This imperfectly drained soil with a distinct compact layer in the lower subsoil occurs in the valleys, or agricultural areas. Typically it is associated with the Harleton, Dewart, and Allenwood soils. It has developed on weathered pre-Wisconsin till derived principally from acid gray shale, sandstone, and quartzite. In many respects it is very similar to Watson gravelly silt loam, both in character and in productivity. The Watson soil, however, has developed from pre-Wisconsin till and residuum. Erosion of this Warrior soil is slight to moderate in cleared areas; from one-fourth to three-fourths of the original surface soil has been lost but no gullies were observed.

The 6- to 8-inch surface soil consists of grayish-brown mellow gravelly silt loam. In wooded areas the upper 3 inches is darkened by decaying organic matter. The upper subsoil, a moderate yellowish-brown friable clay loam, extends to depths of 24 to 30 inches. It grades into a yellow and yellowish-brown compact clay loam with splotches of gray. Weathered moderate-brown till of pre-Wisconsin age, derived principally from acid gray shale, underlies the compact layer at 36 to 40 inches. Numerous rounded pebbles are mixed with the soil layers and parent material.

The subsoil is strongly to very strongly acid in most places. Compactness and impaired permeability of the lower subsoil inhibit the absorption and percolation of water and result in greater erosion and losses of organic matter.

Use and management.—In natural adaptation, problems of management, and proportion of crops grown at the time of the survey, Warrior gravelly silt loam is similar to Watson gravelly silt loam. An estimated 70 percent of Warrior gravelly silt loam was cleared, about 60 percent was used regularly for crops, 5 percent was in pasture, and 5 percent was idle. Crops grown on this soil are more sensitive to wet seasons than when grown on the well-drained soils. Tilling conditions are favorable, although in spring the soil is not ready for crops so early as the better drained soils of the area. The same recommendations as those given for Watson gravelly silt loam are applicable to Warrior gravelly silt loam (see management subgroup 5B in table 9).

Where this soil lies adjacent to limestone ridges, the subsoil is slightly heavier and less acid than typical. Alfalfa and a few other crops that are heavy feeders on calcium do better in such places.

Warrior gravelly silt loam, eroded phase (3–8% slopes) (WA).—This phase differs from Warrior gravelly silt loam only in having lost more soil material through erosion. From one-fourth to three-

fourths of the original surface soil has been lost. Shallow gullies, in most areas more than 100 feet apart, have formed in all fields. Although the gullies have cut into the subsoil material slightly, they can be crossed by farm machinery in most places.

Use and management.—All of this eroded phase has been cleared. Except for several small patches in pasture or abandoned, it is being used for crops. Yields are nearly the same as or about 5 percent lower than on Warrior gravelly silt loam. Contour tillage, strip cropping, and sodding of waterways are needed. The content of organic matter and nitrogen needs to be increased by growing legumes, preferably deep-rooted ones. Lime, phosphorus, and potash should be used as needed. This soil is in management subgroup 5B of table 9.

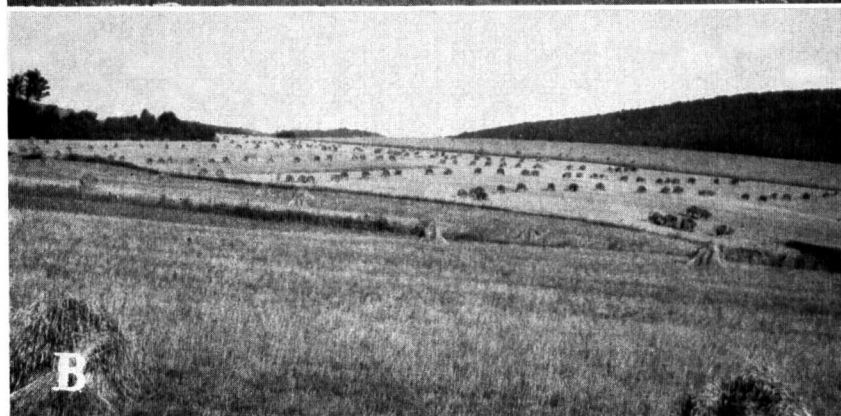
Warrior gravelly silt loam, eroded sloping phase (8–15% slopes) (W_B).—Cultivated fields on this phase are subjected to more erosion than those on Warrior gravelly silt loam, and the silty surface soil, 2 to 4 inches thick, is a little shallower in most places. Gullies form readily in clean-cultivated areas.

Use and management.—At the time of the survey about 65 percent of this eroded sloping phase had been cleared of forest, and, of this, 50 percent was in pasture and about 10 percent was idle. Since this soil has greater runoff and less organic matter than the less sloping Warrior phases, its crop yields are lower. Close-growing crops, preferably legumes and grasses, should make up at least 50 percent of the rotation. Terraces may be effective where intertilled crops must be grown. See management subgroup 5B in table 9 for additional suggestions.

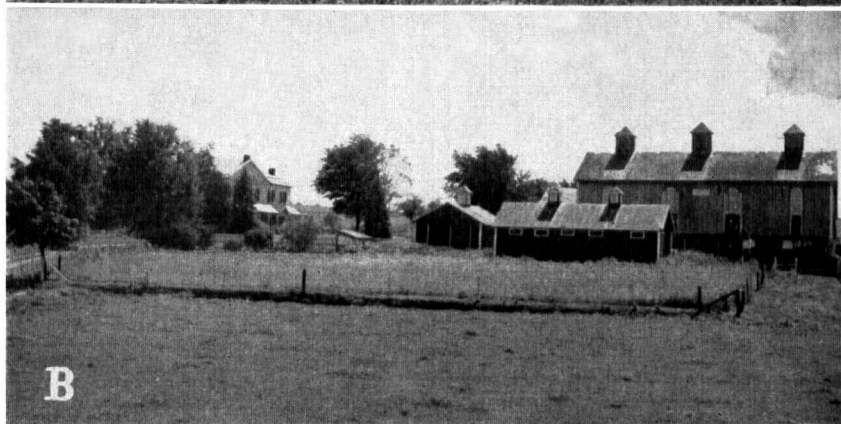
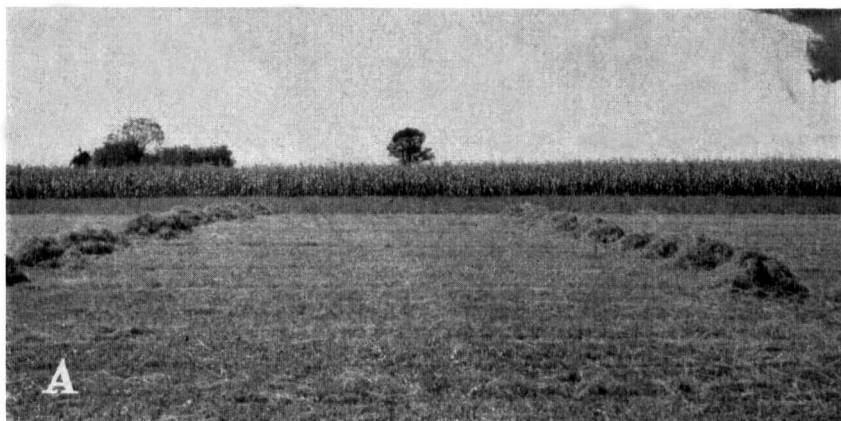
Washington gravelly silt loam (2–8% slopes) (W_c).—A considerably greater number of rounded and angular fragments of limestone, shale, and sandstone occur in the upper layers of this soil than in those of Washington silt loam, but they do not seriously interfere with tillage. The two soils are very similar in other characteristics, such as slope, permeability, thickness of soil layers, water-holding capacity, organic-matter content, fertility, adaptation to crops, and soil requirements. The boundaries between the two soils are not always well defined, since the content of coarse material varies greatly from place to place. Erosion of this gravelly silt loam is slight to moderate; the degree of erosion largely depends on the slope.

Use and management.—At the time of the survey more than 95 percent of Washington gravelly silt loam was used for all the kinds of crops grown in the section; the rest was in pasture. Yields and management are about the same as on Washington silt loam. The soil is well suited to intensive use for crops. With adequate use of lime, phosphate, potash, and nitrogen, and proper crop rotations, relatively high yields of all crops can be consistently obtained. Additional suitable practices are given under management subgroup 1A in table 5.

Washington gravelly silt loam, eroded phase (2–8% slopes) (W_d).—The differences in profile between this phase and Washington gravelly silt loam are not great. Shallow gullies occur on this eroded phase, whereas only sheet erosion was evident on Washington gravelly silt loam at the time of the survey. All of this eroded phase has been cleared, and practically all of it is used for grain crops, vegetables, alfalfa, and soybeans. Average crop yields are slightly lower than on Washington gravelly silt loam.



- A*, Deep gullies on Stephensburg shaly silt loam, eroded rolling phase. Cover is buckwheat. Kistler shaly silt loam, eroded hilly phase, on lower slope in middle distance is abandoned.
- B*, Wheat on Stephensburg shaly silt loam, eroded phase, about 1 mile northeast of Kaseville. Steep forested area is Welkert channery silt loam, steep phase.
- C*, Wheat on Stephensburg shaly silt loam about 2 miles south of Strawberry Ridge.



- A, Big yields of alfalfa and corn on Washington silt loam in Montour County. This is a fertile soil.
- B, Typical farmstead on Washington silt loam about 2 miles southeast of California.
- C, Wheat on Washington silt loam. Almost bare slope, right center, is Stephensburg shaly silt loam. Welkert soils are on ridge in background.

Use and management.—The loss of soil material through erosion has been accompanied by loss of organic matter and plant nutrients, a lowering of the water-supplying capacity, and an increase in difficulty of maintaining good tilth. Nevertheless, this is one of the better soils of the area for crops. It has a favorable physical characteristic, and excellent response can be expected from good management, especially adequate fertilization and the proper rotation of crops. This soil is in management subgroup 1A of table 5.

Washington silt loam (2-8% slopes) (WE).—This is one of the best soils in Pennsylvania. It is a dominant agricultural soil in the northern part of the area and compares favorably in productivity with the Hagerstown soils of Lancaster County and the Cumberland Valley. It is well drained and deep and occurs on undulating relief (pl. 6, A). Erosion is slight to moderate; less than three-fourths of the original surface soil has been lost. The parent material is weathered pre-Wisconsin till and residuum derived principally from gray, high-grade limestone. This soil is associated with the more slowly drained Turbotville and the well-drained Crestmore soils, which were also derived principally from soil materials from limestone.

The 6- to 8-inch surface layer is brown mellow silt loam that is easily kept in good tilth. This is underlain to depths of 12 to 14 inches by yellowish-brown friable silt loam. The lower subsoil is strong-brown to light reddish-brown firm coarsely granular silty clay. The underlying weathered parent material, beginning below 40 inches, consists of yellowish-brown or yellowish-red stiff firm somewhat blocky to platy silty clay. Although less permeable to water and air movement than the overlying layers, this substratum does not materially interfere with underdrainage. It acts as a storage basin for moisture and is readily penetrated by deep-rooted crops. A few fragments of Helderberg limestone and small pieces of shale and sandstone are scattered throughout this soil but do not obstruct tillage.

In most places the surface soil and subsoil are moderately to strongly acid, and the material below 40 inches is moderately acid to alkaline, depending on the amount of limestone influence. The organic-matter content is relatively high except where it has been depleted by erosion.

Use and management.—The early settlers recognized the productivity of Washington silt loam. It was one of the first soils to be used. Probably 98 percent of it was in cultivation at the time of the survey, and most of the rest was in pasture or covered by farm buildings (pl. 6, B). The soil has a wide range of adaptation, and under good management all crops return good yields. Corn, wheat, oats, hay crops, soybeans, and potatoes and other vegetables are grown. The soil is excellent for wheat (pl. 6, C). Clovers and alfalfa are especially well suited, partly because of the relative richness of the subsoil in calcium. Fruits do exceptionally well on this deep soil where air drainage is adequate. Vegetables have high yields but do not mature so early as on the well-drained sandier soils of the area.

This soil is well suited to intensive use for crops. Crops respond well to phosphate and nitrogen fertilizers and small applications of lime. The soil is probably relatively high in potash, but legumes and vegetables may show a response to it. See management subgroup 1A in table 5 for additional suggestions.

Washington silt loam, eroded phase (4-8% slopes) (WF).—Except for slight differences in erosion, this phase is similar to Washington silt loam. Most of it is undulating. Shallow gullies, more than 100 feet apart in most places, are scattered through all areas but can be crossed with farm implements. Adjacent to the gullies, sheet erosion is more pronounced than on Washington silt loam.

Use and management.—Slightly lower yields are produced on this phase than on Washington silt loam, and more amendments are required to maintain production. Controlling erosion and conserving soil moisture are not difficult where crops are properly chosen and adequate amendments are used. Contour tillage is desirable, and terracing may be feasible in some fields. This soil is in management subgroup 1A of table 5.

Washington silt loam, eroded rolling phase (8-15% slopes) (Wg).—This soil occupies a small total acreage in areas adjoining Washington silt loam. It differs from that soil principally in occupying steeper slopes and in being moderately eroded. Gullies form readily in clean-cultivated areas. Spots from which all of the original surface soil and a small part of the original subsoil have been lost are shown on the map by symbol. In several gravelly areas, also shown on the soil map by symbol, angular and rounded shale, sandstone, and limestone fragments compose over 20 percent of the upper soil layers. These fragments interfere with tillage but do not seriously affect the physical condition and productivity of the soil. Several small areas with slopes ranging from 15 to 30 percent have also been included. Most of these steeper areas are moderately eroded, but a few are not noticeably so.

Use and management.—At the time of survey probably 98 percent of Washington silt loam, eroded rolling phase, was used for the general crops of the area or alfalfa, soybeans, and potatoes and other vegetables. A few small patches were in permanent pasture. Primarily because of greater runoff and consequent loss of plant nutrients, crop yields are 5 to 10 percent below those on Washington silt loam. An increase in the acreage of alfalfa is desirable. Alfalfa or a suitable legume-grass mixture should occupy this soil at least 50 percent of the time. See subgroup 2A in table 6 for additional management suggestions.

Watson gravelly silt loam (3-7% slopes) (WH).—This soil, characteristically located in the valleys of the two counties on mild upper slopes, is imperfectly drained and has a distinct compact layer in the lower subsoil. It has developed on weathered pre-Wisconsin till and residuum derived principally from acid gray shale, sandstone, and quartzite. It is associated with the well-drained Dewart soils. Erosion is slight to moderate on cleared areas; from one-fourth to three-fourths of the surface soil has been lost.

The surface soil in cleared areas is grayish-brown very friable gravelly silt loam. From depths of 6 or 8 inches down to 24 inches the material is yellowish-brown friable silty clay loam. In many places the upper part of this layer has a brown ochereous color suggestive of a rather high content of iron oxide. Lack of oxidation of the iron compounds is indicated, however, for as depth increases the brighter colors become less pronounced and the material more com-

pact. Beginning at 20 to 30 inches below the surface there is a moderately compact, blocky, mottled gray and yellow silty clay loam layer containing many gray sandstone and shale fragments. These are 2 to 6 inches in diameter and in the early stages of disintegration and discoloration. The compact layer extends into the underlying weathered moderate brown till. Although this compact layer is not entirely impervious to water, it does interfere with underdrainage. It has some porosity besides that due to included coarse materials but releases excess water slowly. In consequence, the soil layers above remain wet for a considerable time after heavy rains.

The soil and parent material are highly leached and very strongly to extremely acid under undisturbed forest cover. In many places seepage water from higher slopes, as well as the structure of the lower subsoil, causes poor underdrainage.

Use and management.—At the time of the survey about 40 percent of Watson gravelly silt loam was cleared; 10 percent of the cleared land was partly in pasture and partly idle, and most of the rest was used for general crops, soybeans, and buckwheat. Spring planting ordinarily begins a week later on this soil than on the well-drained soils. Yields of important field crops are lower than on the Allenwood soils. Alfalfa, fruit trees, and vegetables are poorly suited.

Lime and fertilizers containing nitrogen, phosphorus, and potassium are essential for maintaining average to good yields. Suggestions for management are given under subgroup 5B in table 9.

Watson gravelly silt loam, eroded phase (3–7% slopes) (W₁).—This phase is distinguished from Watson gravelly silt loam by its more advanced erosion. It has shallow gullies, mostly over 100 feet apart. In a few fields, however, the gullies are less than 100 feet apart and somewhat interfere with tillage.

Use and management.—At the time of the survey all of this soil had been cleared and, except for about 10 percent partly in permanent pasture and partly idle, was being used for the crops commonly grown in this section. Crop yields are slightly lower than on Watson gravelly silt loam. Somewhat more care is needed to control erosion than is required for Watson gravelly silt loam, but only simple erosion control measures, such as contour tillage, strip cropping, and sodding of waterways, are necessary. Suitable management practices are given under subgroup 5B in table 9.

Watson gravelly silt loam, eroded sloping phase (7–12% slopes) (W₂).—This phase is associated with other Watson soils on middle and upper slopes in the valleys of both counties. Because it has steeper slopes than Watson gravelly silt loam, erosion has removed much of its original surface soil and even a part of the subsoil in cleared areas. Runoff is greater than on the well-drained soils having the same slope, and gullies form readily in the areas planted to clean cultivated crops.

Use and management.—At the time of the survey about 80 percent of this eroded sloping phase was cleared. From 5 to 10 percent of the cleared land was idle or abandoned, and the rest was largely used for general crops. This is a fair pasture soil where lime and phosphate are used, but only a few small patches are in permanent pasture. Crops yield about 5 to 10 percent less than on Watson gravelly silt loam because of greater runoff and increased loss of organic matter.

Close-growing crops—including small grains, timothy, clover, and soybeans—should be favored. This soil is in management subgroup 5B of table 9.

Watson gravelly silt loam, strongly sloping phase (12–25% slopes) (W_K).—Owing to its greater slopes, this phase has a somewhat better drained subsoil in most places than Watson gravelly silt loam. It is nevertheless subjected to seepage water from higher lying slopes and does not become ready for use until about a week later in spring than the well-drained soils. A large part of the surface soil, as well as some of the subsoil, has been lost from cleared areas of this strongly sloping soil.

Use and management.—At the time of the survey about 90 percent of the soil was in forest, its best use. The remaining small acreage was divided almost entirely between crops, idle land, and pasture. This soil is not so productive of crops as Watson gravelly silt loam, for it has greater relief and is more susceptible to erosion. Yields are 25 to 30 percent below those obtained on the smoother Watson gravelly silt loam. The cropping system is largely one of planting corn and hay in alternate years.

The soil is not considered well suited to intertilled crops, but an occasional row crop can be grown without decreasing productivity if a high level of management is practiced. The rotation would need to be long and consist largely of close-growing legumes and grasses. The susceptibility of this soil to erosion makes it difficult to conserve. Fertilization is necessary for the production of most crops and pastures, as the soil is deficient in lime, organic matter, phosphorus, and potassium. See subgroup 5B in table 9 for additional information on management.

Watson stony loam (5–12% slopes) (W_L).—This soil occurs below the Weikert soils and Rough stony land (DeKalb soil material) on the lower slopes of high mountains. It is essentially a forest soil. The few small cleared patches have lost one-fourth to three-fourths of the surface soil and a considerable quantity of organic matter through erosion.

The surface 8 to 10 inches is grayish-brown very friable stony loam. This is underlain by yellowish-brown friable loam or sandy clay. At depths of 20 to 30 inches the content of clay increases and gray splotches occur. This material is neither plastic nor exceptionally heavy, but because of seepage water from the higher lying slopes it remains moist a large part of the year. Shale and sandstone fragments of various sizes are strewn over the surface and mixed with the subsoil layers.

Use and management.—In most places stones are so large and numerous that clearing and cultivation of this soil would be impractical. It has only low to moderate productivity. It is rather severely leached, extremely acid, and low in organic matter and other plant nutrients; consequently, it is best suited to forest, its principal use. This soil is in management group 9 of table 13.

Watson stony loam, strongly sloping phase (12–28% slopes) (W_M).—The differences between this soil and Watson stony loam are related to differences in slope. All of this soil has received some talus from the higher lying Rough stony land (DeKalb soil material).

Practically all of this phase is in forest, its best use. It is classed with the soils of management group 9 in table 13.

Weikert channery silt loam (2-12% slopes) (W_N).—This well-drained shallow soil has developed from a thin mantle of pre-Wisconsin till and residuum. It occurs on rather high ridges and hills in association with the other Weikert soils. Runoff is not excessive. Erosion is slight to moderate in cleared areas. Almost none to one-half the original surface soil has been removed. Small fragments of shale help to hold the soil in place. Although very similar to Hartleton channery silt loam, this channery silt loam is more shallow and has a thinner mantle of soil material over grayish or yellowish-gray unweathered shale.

The 6- to 8-inch surface soil is light-brown loose porous silt loam; it contains many flat and angular shale fragments 3 to 5 inches wide and about 1 inch thick. At depths between 8 and 15 inches is light-yellow friable silt loam or silty clay loam soil mixed with numerous angular and flat shale fragments. Below this material the bedded shale is encountered. In most places the shale has been twisted and broken, perhaps by frost action. Silty soil material has formed a film in the crevices that increases the water-storage capacity. Some areas of the soil lie over hard unbroken shale layers, and root, air, and moisture penetration end abruptly where the soil material comes in contact with the layered shale formation.

This soil is very strongly to extremely acid throughout. It is low to moderately low in organic matter and other plant nutrients.

Use and management.—At the time of the survey an estimated 50 percent of Weikert channery silt loam was used for the general crops of the area, and soybeans, alfalfa, and fruit. About 30 percent was in forest, 15 percent was idle, and 5 percent supported a scant pasture growth. Yields partly depend on the thickness of the upper layers and proportion of fine material in them. Many areas once cultivated are now idle or reforested because of low yields. Air drainage is generally better on this soil than on the soils in the valleys, and some of it is used for fruit production.

This soil is early to warm up in spring. Owing to the absence of heavy subsoil material, crops are damaged by droughty spells in summer; but plant roots can penetrate to greater depths than in the more droughty Kistler and Kutztown soils, where the shale immediately beneath the soil mantle is more solid. The surface layer is not generally difficult to cultivate or plow, except in places where most of the shale fragments are more than 5 or 6 inches in diameter and comprise over 40 percent of the material.

This soil is not very productive of most crops, because of its shallow depth, low water-holding capacity, and rather low fertility. The soil responds to frequent fertilization, and lime is necessary for best crop production. From 1 to 1¼ tons of ground limestone or its equivalent, applied once in the rotation, should be enough. This soil is in management subgroup 3B of table 7.

Weikert channery silt loam, eroded hilly phase (20-35% slopes) (W_o).—In depth, proportion of shale, and other soil characteristics this phase occurring on the slopes and sides of high hills is similar to the less sloping eroded Weikert soils. Erosion has thinned its

surface soil, however, and reduced its organic-matter content to a greater extent. Shallow gullies have formed in all fields, and deep gullies in a few.

Use and management.—At the time of the survey about 75 percent of this soil was used for crops, 20 percent was idle or abandoned, and 5 percent was in permanent pasture. Probably much of this soil should never have been cleared. It produces low yields and is difficult to cultivate. Erosion cannot be controlled where row crops are grown. Many fields have been reforested to pines and cedars. Idle fields have grown up in weeds and coarse grasses. In normal years yields of all crops are low.

This soil is considered poorly suited to crops because of its strong slopes, low water-holding capacity, and low fertility. On many farms the cleared areas are probably not suited to pasture. The soil is not naturally productive of forage plants, but good pastures can be established and maintained under a high level of management. Lime and phosphate are the chief treatments needed. See management subgroup 8B in table 12 for additional information on management.

Weikert channery silt loam, eroded rolling phase (12–20% slopes) (W_R).—Erosion is moderate in most places on this phase. One-half to practically all of the original surface soil has been washed down the slopes. Shallow gullies occur in all fields, and deep gullies have formed in a few poorly protected ones. The profile features are similar to those of Weikert channery silt loam.

Use and management.—At the time of the survey crops were grown on about 75 percent of this eroded rolling phase. Alfalfa, soybeans, tomatoes, and potatoes are grown to some extent, but the main crops are corn, oats, wheat, and mixed clover and timothy hay. Yields are 10 to 15 percent lower than on Weikert channery silt loam. Although the fragments of shale in this soil offer considerable resistance to erosive forces, the erosion has been and is serious. Erosion can be controlled by strip cropping, contour tillage, sodding of waterways, and use of a minimum of intertilled crops in the rotation. Lime, nitrogen, and phosphorous are needed; potash may be deficient for specific crops.

This soil is not especially productive of pasture, because of shallow depth, low water-holding capacity, and rather low inherent fertility. Nevertheless, on many farms pasture is probably its best use. See subgroup 4B in table 8 for additional information on management.

Weikert channery silt loam, eroded steep phase (35–50% slopes) (W_Q).—The original surface layer has been largely lost from most areas of this soil, and its organic-matter content has been greatly depleted. Shallow gullies have formed in all fields and deep gullies in many.

Use and management.—This steep soil is ill-suited to tilled crops or even pasture. The unfavorable factors are rough steep terrain, natural low fertility, rapid runoff, and droughtiness. At the time of survey approximately 50 percent of the soil was used for crops, principally hay and corn, and 35 percent was idle or abandoned. About 10 percent was in pasture grasses, and 5 percent had reverted to forest. Yields of crops are low.

Where the soil is to be used for pasture, the main soil treatments required are applications of lime and phosphate and proper choice of

pasture plants. This soil is classed with the soils of management subgroup 8B in table 12.

Weikert channery silt loam, hilly phase (20–35% slopes) (W_R).—Although otherwise similar to Weikert channery silt loam, this phase occupies steeper slopes. It is largely in forest; less than 10 percent had been cleared at the time of the survey. On cleared areas runoff is rapid. If the soil is left unprotected, gullies soon form and sheet erosion becomes serious. Crop yields on the cleared areas are 30 or 45 percent lower than on Weikert channery silt loam. Cleared areas should be seeded to permanent pasture or meadow. This soil is in management subgroup 8B in table 12.

Weikert channery silt loam, rolling phase (12–20% slopes) (W_s).—This soil occurs largely on the tops of ridges and on higher slopes in the agricultural sections of the two counties. Runoff is greater than on Weikert channery silt loam, but erosion is slight in most places and gullies are extremely rare.

Use and management.—At the time of the survey about 45 percent of this soil was in crops and 45 percent in forest. The rest was largely idle or abandoned. Crop yields are about 5 percent lower than on Weikert channery silt loam. Because of its shallowness and low water-holding capacity, this phase is not especially well adapted to shallow-rooted grasses and small grains. See subgroup 4B in table 8 for additional information on management.

Weikert channery silt loam, steep phase (35–50% slopes) (W_T).—This phase is similar to Weikert channery silt loam under forest cover, but it occupies steep slopes. Most of the shale fragments in the soil are 1 to 5 inches in diameter, although flaggy and stony fragments more than 5 inches in diameter are abundant in places.

Use and management.—At the time of the survey practically all of Weikert channery silt loam, steep phase, was in forest (pl. 5, B). Forest growth is slow and lumbering is difficult in places, but the soil is much better suited to forest than to pasture or crops. Cleared areas should be seeded to permanent pastures or reforested. This soil is in management subgroup 8B, as shown in table 12.

Weikert channery silt loam, very steep phase (50–70% slopes) (W_T).—This soil is entirely nonagricultural; it supports a scrubby timber growth consisting principally of oaks. The soil material and shale are mixed and have no definite layers or horizons. A description of the kind of material found in this soil is given under Weikert channery silt loam. In many places tree roots can penetrate 3 to 5 feet, but in some areas bare shale is exposed and there is only a scant scattered growth of trees. The most suitable use for this soil is forestry, as shown in management group 9 of table 13.

Weikert flaggy loam (5–20% slopes) (W_v).—This soil differs from Weikert channery silt loam in having larger and thicker shale and sandstone fragments (1 to 2 inches thick and 5 to 10 inches long) and less soil material. It occupies the tops of ridges. The soil is droughty, low in fertility, and capable of supporting only slow-growing, scrubby timber. Below 15 inches only thin films of fine material have lodged in the crevices. Areas where the material is stony rather than flaggy were included with this soil because of similar unfavorable characteristics for plant growth.

Use and management.—Probably 35 percent of Weikert flaggy loam had been cleared at the time of the survey, and most of this had been abandoned. Because the upper 15 inches is more than 80 percent coarse shale and sandstone fragments and less than 20 percent soil, this flaggy loam is unsuitable for crops or pasture. The few patches planted to crops produce extremely low yields. The most suitable use of this soil is forestry, as is shown under management group 9 of table 13.

Weikert shaly silt loam (3–12% slopes) (Ww).—Many small shale fragments in the upper layers, mostly thin shale chips less than 2 inches in length, differentiate this soil from Weikert channery silt loam. The fragments make up 30 to 75 percent of the top 10 inches of material and a larger percentage of the underlying material. The soil occurs on the ridges of the higher hills in the area underlain by thin platy layers of Clinton and Chemung shales. Erosion is slight to moderate on cleared areas. Some areas of this shaly silt loam were mapped with areas of Weikert channery silt loam because of the similarity of the two soils.

In a typical profile of Weikert shaly silt loam, the surface soil consists of 6 to 8 inches of light-brown porous silt loam and small grayish-brown shale chips. From 8 inches down to 15 inches occur loose shale fragments and silty soil material, the shale forming more than 75 percent of the total material. Below 15 inches there is mostly thin platy shale containing a small amount of silty soil material that has accumulated in the crevices. The underlying shale is almost impervious to roots and water.

Use and management.—At the time of the survey about 45 percent of Weikert shaly silt loam was used for crops, 30 percent was in forest, 20 percent was idle or abandoned, and about 5 percent was in permanent pasture. Crop yields are somewhat lower than those on Weikert channery silt loam, which has a similar surface relief. In addition, this soil has a higher percentage of rock fragments than Weikert channery silt loam. Although erosion control on this shaly silt loam is not difficult, it should be considered in planning management.

This soil is low in plant nutrients, water-holding capacity, and organic matter. When used for pasture or crops, heavy applications of lime and phosphates should be made. Nitrogen fertilizers will aid in establishing pastures and in promoting the growth of nonlegume plants. The soil probably contains sufficient potash for most plants. Suggestion for management will be found under subgroup 3B in table 7.

Weikert shaly silt loam, eroded rolling phase (12–20% slopes) (Wx).—Erosion has removed one-fourth to nearly all of the original surface soil from this phase, which in other respects is similar to Weikert shaly silt loam. Shallow gullies occur 50 to 200 feet apart, and a few deep gullies have formed in poorly protected fields. Tilth has been impaired and crop yields have decreased.

Use and management.—At the time of the survey all of Weikert shaly silt loam, eroded rolling phase, had been cleared, and nearly 5 percent had reverted to forest. Nearly 20 percent was idle or abandoned; the rest was largely used for crops. Contour tillage and strip cropping should be practiced and use of legumes and hay crops should

be increased for protection against erosion and maintenance of fertility. This soil responds to applications of nitrogen and phosphate fertilizer for all crops, and possibly addition of potash would benefit legumes. Physically the soil is probably better suited to permanent pasture than to intertilled crops and small grains. Low water-holding capacity, susceptibility to erosion, and low inherent fertility indicate that pasture would be the best use. This soil is in management subgroup 4B, as shown in table 8.

Weikert shaly silt loam, rolling phase (12–20% slopes) (W_r).—This phase differs from Weikert shaly silt loam in occupying stronger relief. Runoff is faster, and erosion is somewhat more difficult to prevent. From one-fourth to three-fourths of the original surface soil has been removed, and the supply of organic matter has been lowered.

Use and management.—At the time of the survey crops were grown on about 50 percent of this soil, forest covered about 35 percent, and the rest was partly in pasture grasses and partly abandoned. Crop yields are about 10 to 15 percent less than on Weikert shaly silt loam. Fertilizer requirements are similar to those of Weikert shaly silt loam, but crop rotations should include a higher percentage of legumes and grasses. See subgroup 4B of table 8 for additional information on management.

Wheeling loam (0–12% slopes) (W_z).—This well-drained soil is one of the best for agriculture in the two counties. It has developed on material originally deposited as alluvium that now lies on terraces 25 to 100 feet above the river beds and beyond reach of floodwater. The parent material, derived principally from sandstone and shale, is characterized particularly by being underlain at depths of 3 to 5 feet by interstratified layers of sand and gravel. The rate of runoff varies with the steepness of the slope. This soil is associated with the imperfectly drained Sciotoville, the poorly drained Ginat, and the very poorly drained Chilo soils on the Susquehanna River terraces.

The 6- to 10-inch surface soil is a pale-brown mellow porous loam to silt loam containing considerable organic matter. The thickness of the surface soil varies according to losses from erosion, which are generally slight. On some areas, however, erosion has caused the loss of about one-half of the original surface layer. The subsoil is a moderate yellowish-brown friable clay loam having a faint reddish cast. The underlying material, below 36 inches, is more sandy and gritty and contains numerous small rounded pebbles of sandstone and shale derivation. A few crystalline pebbles are widely scattered among the others.

This soil is very strongly acid except where the upper layers have been changed by addition of commercial lime. Both surface soil and subsoil drainage are adequate, and much excess water passes rapidly through the porous substratum. The inherent fertility is less than that of some of the heavier soils of the uplands, such as members of the Washington, Turbotville, and Kreamer series. Nevertheless, yields of most crops on Wheeling loam are similar to yields on those soils, possibly because of its better physical conditions.

Use and management.—Wheeling loam is considered a good soil chiefly because of its desirable tillage characteristics and high yields

under normal fertilization. Practically all of it has been cleared, and, except for areas covered by town property, it is used for all kinds of crops grown in the two counties. Corn and vegetables do as well on this soil as on the more fertile Washington soils, but wheat, barley, and legumes do better on the heavier soils and on those of higher lime content.

This soil warms up early in the spring and can be worked under almost any moisture condition without harmful results. Complete fertilizer, manure, and lime should be used. The soil is well suited to pasture, but because of its productivity and the ease with which it can be worked, it is favored for crops requiring tillage. See subgroup 1B in table 5 for additional management information.

Wheeling sandy loam (0-12% slopes) (W₂).—A greater quantity of sandy material in the surface soil and subsoil distinguishes this soil from Wheeling loam. It is associated with other Wheeling soils and occupies almost level to undulating areas on the terraces of the Susquehanna River. Practically all of it lies above overflow.

The soil consists of 7 to 10 inches of light yellowish-brown sandy loam or fine sandy loam surface soil, underlain by yellowish-brown loam and sandy clay to depth of 30 to 36 inches. Numerous small rounded sandstone, shale, and quartzite pebbles are at depths of 3 to 5 feet. These pebbles are mixed with sandy material, which is porous and permits downward percolation of excess water. Tilth conditions are excellent.

Use and management.—All of Wheeling sandy loam except a few areas covered by town property is used for crops. It is less productive than Wheeling loam, and is slightly better suited to corn and potatoes and other vegetables than to wheat, oats, or hay crops. Deep-rooted plants withstand droughty spells on this soil remarkably well, but shallow-rooted plants are considerably damaged during prolonged dry periods. Some tobacco is grown, and yields are good.

This soil is inherently low in lime, phosphorus, and potash; it responds well to treatments of fertilizer and manure. Sod crops or legume crops should be used to maintain supplies of organic matter. See subgroup 1C in table 5 for additional information on management.

Wheeling sandy loam, eroded strongly sloping phase (12-20% slopes) (W₃).—This soil differs from Wheeling sandy loam in having greater slope, which has encouraged loss of surface soil and organic matter. Erosion is not serious, however, for the porosity of the soil allows rapid absorption of rainfall. From one-half to three-fourths of the original surface soil has been lost in most places.

Use and management.—Shallow gullies form readily in cultivated fields. Crop yields are 5 to 10 percent below those ordinarily obtained on Wheeling sandy loam, and management problems are necessarily more complicated. Contour tillage, strip cropping, and sodding of waterways are essential if row crops are to be grown.

The soil is relatively low in organic matter and plant nutrients, and the water-holding capacity has been impaired by erosion of the surface soil. Crop rotations should be long and include a large proportion of legumes, preferably deep-rooted legumes, to build up the supply of organic matter and the water-holding capacity. Lime and complete fertilizer are also essential for maintaining maximum yields of most

crops. This soil is in management subgroup 2B, as is shown in table 6.

Wheeling silt loam, eroded shallow phase (3-12% slopes) (W4).—The undulating to moderately rolling areas occupied by this soil are on high river terraces where bedrock is fairly close to the surface. This phase is well drained. In fact, areas that have less than 18 inches of soil over bedrock are droughty. Erosion has removed from one-fourth to three-fourths of the original surface soil. Gullies, mostly shallow ones more than 300 feet apart, have formed in some fields.

The surface 6 to 8 inches consist of light yellowish-brown mellow very fine sandy loam to silt loam. This is underlain by moderately yellowish-brown friable clay loam. Shale bedrock is encountered at depths of 36 inches or less. In most places the depth to bedded shale ranges from 18 to 36 inches. As the soil areas are scattered, they are underlain by various shale formations. Most of these shale formations are acid, but in the vicinity of Milton calcareous Salina shale underlies the Wheeling soils. The shale formations have contributed only slightly to the character of the overlying soil material.

Use and management.—Compared with the deeper soils of the Wheeling series, this eroded shallow phase is somewhat more droughty and less fertile. At the time of the survey nearly all of it had been cleared and was being used for crops. Small patches are included within town boroughs and are occupied by buildings. Yields are less than those on Wheeling loam because this soil has a lower content of organic matter and less storage space for water and plant nutrients. General crops of the area and soybeans, alfalfa, and vegetables are grown. Like the other Wheeling soils, this one responds well to fertilizer and other treatments. Where soil treatments are used, the soil is well adapted to most crops, especially corn. Contour tillage is desirable; terraces may be essential where row crops are grown frequently. Suitable crop rotations are shown in management subgroup 3B of table 7.

Wheeling silt loam, eroded strongly sloping shallow phase (12-20% slopes) (W5).—This phase occupies steeper slopes than Wheeling silt loam, eroded shallow phase. The dominant range in slopes is 12 to 20 percent, but slopes ranging up to 30 percent appear in a few places. This soil has practically the same depth of soil material over shale as Wheeling silt loam, eroded shallow phase, but erosion has left its surface soil slightly thinner and made a few more gullies. The gullies are shallow; they do not interfere with cultivation and are readily covered up during ordinary tillage. About half of the original surface soil has been washed from this phase.

Use and management.—At the time of the survey an estimated 75 percent of Wheeling silt loam, eroded strongly sloping shallow phase was in crops, 15 to 20 percent was idle, and the rest was in pasture grasses and woodland. Crop yields are about 10 percent lower than on the eroded shallow phase. As on other sloping and strongly rolling areas, problems of management are more intricate, conservation is more difficult, and crop yields are lower than on similar soils on milder slopes. To maintain crop yields, long rotations that include a large proportion of legumes and grasses are required. Fertilizer

and lime requirements are similar to those of Wheeling loam, except that more nitrogen and organic matter should be added. Manure, in addition to use of legumes, will materially aid in improving productivity. Suitable rotations are given under management subgroup 4B in table 8.

Williamsburg silt loam (0-5% slopes) (W6).—This comparatively fertile imperfectly drained soil occupies terraces along the streams that drain the limestone and calcareous shale areas. Most of the material from which it has developed was laid down by these streams when they flowed at higher levels and under slack-water conditions. Some material, however, was washed from adjacent higher slopes. The lay of the land is favorable for runoff, yet does not encourage erosion. The slopes exceed 5 percent in only a few places, and erosion has not removed more than one-fourth to one-half of the original surface soil. This soil is associated with the Montgomery soil, and boundaries between the two are not always well defined.

The surface soil of Williamsburg silt loam is a friable mellow dark grayish-brown silt loam. From depths beginning at 8 to 15 inches, the subsoil is light yellowish-brown friable, but moderately firm, silty clay loam. It is well aerated and permeable to roots and moisture. This friable layer extends to a depth of 24 or 30 inches in some places. Below this friable layer is the lower subsoil, a mottled yellow, brown, and gray stiff plastic silty clay. The parent material is very similar to the lower subsoil but is slightly coarser in texture.

For the most part, this soil is well supplied with lime. It is not necessary to add any lime for most crops. The surface soil and upper subsoil range from moderately acid to neutral; the lower subsoil is near neutral. The soil dries slowly. It has favorable tilth and a moderate to good supply of organic matter that supplies nitrogen for plant use and benefits the surface structure.

Use and management.—In crop productivity and crop adaptation, the Williamsburg, Wiltshire, and Turbotville soils are similar. The Williamsburg and Wiltshire soils have a better lime supply than the Turbotville soils, but are somewhat inferior in natural drainage. At the time of the survey about 85 percent of Williamsburg silt loam was used for crops, principally the general crops and soybeans and buckwheat. Nearly 10 percent was in pasture grasses, and the rest was small woodlots or idle patches. Yields and adaptation to crops vary somewhat according to drainage conditions. Alfalfa is not well adapted.

Fertilizers high in phosphorus and potash, plus some nitrogen, are effective on this soil. Erosion is not a problem. The soil can be used intensively for adapted crops if necessary treatments are used. Suitable practices are given in management subgroup 5A in table 9.

Wiltshire silt loam (2-6% slopes) (W7).—The parent materials for this imperfectly drained soil are recent deposits eroded from higher lying soils developed on limestone and calcareous shale rocks. These materials have collected on the lower slopes at the heads of small drains. The small narrow areas of this soil receive highly fertile materials washed from the higher lying slopes of the Washington, Hagerstown, Kutztown, and Mifflinburg soils. Such materials accumulate from wash carrying organic and mineral solids. This soil has also been influenced by seepage waters carrying materials in solution.

The surface soil consists of 10 to 20 inches of grayish-brown very friable silt loam, rich in organic matter. The upper subsoil is light yellowish brown with splotches of gray. It is friable and permeable to roots, air, and moisture. Mottled gray, yellow, and brown, heavy, firm silty clay occurs below depths of 20 to 24 inches. This lower material is only slowly pervious to air and moisture; root development is largely restricted to the upper layers.

The surface soil and upper subsoil are slightly acid; the lower layers are neutral to alkaline. Although this soil is high in organic matter and other plant nutrients, its suitability for use is impaired by imperfect drainage and slow runoff.

Use and management.—The water table is normally high in Wiltshire silt loam, and the depth to which good drainage extends varies from place to place. Crops such as corn, oats, soybeans, and mixed clover and timothy are less damaged by this imperfect drainage than wheat, alfalfa, and vegetables. About two-thirds of this soil is used for crops and one-third for pasture.

After the early spring saturation is alleviated by evaporation and drainage, this soil generally remains in good condition for field work and gives little trouble unless exceptionally wet weather prevails. Apparently the supply of calcium is sufficient for all crops. Applications of lime may do more harm than good.

High yields can be obtained by using rotations that include a legume and by applying moderate to heavy applications of phosphate and potash. Suitable rotations are in subgroup 5A in table 9.

USE, MANAGEMENT, AND PRODUCTIVITY OF THE SOILS ^{5a}

GENERAL RELATIONSHIPS

The soil is the natural medium for production of crops. A productive soil makes several distinct contributions toward the growth of plants. Through its physical, chemical, and biological properties it favors the growth of roots into the porous soil layers, thereby giving the plant mechanical support. According to the needs of the particular plant and the supplying power of the soil, the growing roots absorb from the soil plant nutrients, water, and air. In addition, the temperature of the soil has a most important effect on the availability of certain plant nutrients it contains and upon plant growth.

The productivity of a soil depends largely on (1) the characteristics of the soil (internal and external), (2) the management the soil receives, and (3) the climate. These factors are interdependent; that is, a change in one will affect the action of some or all the others. The climatic factor is ordinarily not under the farmer's control.

Management practices and soil characteristics.—The management a soil receives is largely under the farmer's control. It can be varied between wide limits by use of many combinations and intensities of agronomic and engineering elements; for example, by drainage, by use of lime, crop rotations, fertilizer, and various methods of tillage, and by choice of crop varieties. The nature and characteristics of

^{5a} The term "diversion ditch" used in this report is equivalent to "diversion terrace."

the soils on a given farm should greatly influence the selection of suitable sets of management practices and the intensity of their use. For example, on the deep, medium-textured, well-drained soils of slightly acid reaction on moderate slopes, many widely different crops can be grown satisfactorily. The choice is limited primarily by the climate, the relative prices of crops, and the kinds of farming the operator likes. On the other hand, experience and research have shown that most shallow and steep soils are suitable only for permanent pasture or trees. In this latter example, soil slope and depth directly influence the selection of suitable crops.

The experience of farmers in Montour and Northumberland Counties, supported by data obtained by the State agricultural experiment station and the agricultural extension service, demonstrates clearly that the following soil management practices are of critical importance on most farms:

1. Selection of suitable crops and crop rotations.
2. Use of commercial fertilizers.
3. Conservation and wise use of farm manure.
4. Use of lime.
5. Following special tillage practices.
6. Maintenance of organic matter.
7. Control of soil erosion.

In most cases, supplies of organic matter can be maintained and soil erosion controlled by using a suitable combination of the first five practices.

Crop rotations.—The experience of farmers through hundreds of years has shown that growing of alternate crops, especially if one of them is a legume, results in greater yields than growing any one crop continuously. A good crop rotation has several favorable effects. In combination with other good management, it will go far toward controlling erosion and maintaining good soil structure and tilth. It facilitates the control of crop diseases, insects, and weeds. Also, it distributes the need for farm labor over a greater period of time and reduces the chances of complete seasonal failure. Chances of failure are much greater if only a single crop is grown. In spite of its advantages, a crop rotation alone, though it may improve yields, cannot substitute for use of fertilizer and manure.^{ab} This applies with very few exceptions.

A good rotation for Montour and Northumberland Counties might be an intertilled crop such as corn or vegetables for 1 or 2 years, followed by a small grain, and then a legume or legume-grass mixture. Several major soil characteristics should determine which crops are suitable and how many times intertilled crops can safely be grown during one round of the rotation. These characteristics are slope, depth, texture, structure, consistence, and drainage. These same factors also affect the length of time that legumes or grass-legume mixtures should occupy the land. The following illustrate how soil characteristics can limit the choice of crops and crop rotations.

Slope.—The influence of slope can be understood by comparing two phases of Elliber cherty silt loam. The hill phase has slopes of 20 to 40 percent and, because of the erosion hazard, areas now in forest should remain forested. The use most suitable for areas now cultivated is permanent legume-grass pasture.

^{ab} Inoculated legumes, when incorporated into the soil, do increase the supply of soil nitrogen.

In contrast, the same soil (Elliber cherty silt loam) on slopes of 3 to 8 percent is entirely suitable for a number of rotations. For example, a rotation consisting of an intertilled crop, a small grain, and hay or pasture is appropriate. Under good management this phase on slopes of 3 to 8 percent is capable of producing two successive intertilled crops and still maintaining its productivity.

Depth.—Shallow soils such as Kutztown shaly silt loam, eroded phase, are not suitable for orchards. Their shallowness restricts root penetration and limits the supply of water and air to a point that will not allow normal tree growth.

Drainage.—Alfalfa, sweetclover, and similar crops are sensitive to restricted drainage and require deep well-drained soils for normal growth. Several of the soils of Montour and Northumberland Counties, among which are the Alvira, Pekin, Warrior, and Shelmadrine, are not suited to such crops because they have poor or imperfect drainage. They may grow good grass crops such as Kentucky bluegrass and orchard grass, as well as shallow-rooted legumes such as Ladino and white clovers.

Texture.—Because of soil texture, fertilizers, especially nitrogen and potash, are easily leached out of Lakin loamy fine sand, Chenango gravelly loam, and other soils of subgroup 1C, table 5. These soils are deep and have good to somewhat excessive drainage, which favor their warming early in spring. They are recognized as "early" soils and are especially well suited to vegetable crops. Leaching of nutrients can be reduced by keeping a growing crop on the soil and by supplying each crop with the fertilizer it needs instead of making large applications once or twice during the rotation.

Structure and consistence.—Some soils of these counties, as the Allenwood, have one or more horizons in the subsoil that may be inadequately aerated because of a slightly compacted pan formation within 2 feet of the surface. Soils of this kind are not suitable for orchards, nor is it likely that alfalfa will grow well on them.

Fertilizers.—If used efficiently, fertilizers provide an increased and better balanced supply of plant nutrients. This improvement in soil fertility allows farmers a wider choice of crops and produces better yields. Plants require at least 15 nutrient elements, and 12 of these must come from the soil.⁶ Most soils in this area need additions of commercial fertilizers containing nitrogen, phosphorus, and potassium, and sometimes other nutrients are required.

All of the soils in Montour and Northumberland Counties are low in available phosphorus. This is usually the first element that limits crop growth on unfertilized fields. Nearly all of the soils respond to nitrogen fertilizers. A few of the soils still supply sufficient potassium for most crops, but many do not.

The amounts and kinds of fertilizers that should be used are determined principally by: (1) the chemical and physical nature of the soil (concentration and total amounts of available nutrients), depth of rooting zone, amounts and kinds of organic matter, structure and drainage, and reaction or degree of acidity or alkalinity; (2) the kind of crop; and (3) the amount of water (rainfall or irrigation) which will be available to the crop. It is not appropriate to discuss these factors in detail here. It should be made clear, however, that even in an area of one or two counties, the natural variability of the soil, combined with differences resulting from past use, make it impossible to give consistently good "blanket" recommendations as to kinds and amounts of fertilizers to be used.

Probably the best method of determining the amounts and kinds

⁶ The soil supplies phosphorus, potassium, nitrogen, sulfur, magnesium, calcium, iron, manganese, zinc, copper, boron, and molybdenum. Carbon, hydrogen, and oxygen come from air and water. Legumes, under certain conditions, are able to utilize nitrogen from the air.

of plant nutrients needed for given soils is through the use of chemical tests that have been calibrated against field trials on known soil types or phases. Such tests, plus experience with similar soils and crops, enable the specialists in charge of the laboratory to give sound advice on the fertilizer needs of the soil tested.

The Pennsylvania State College operates a soil testing service for all farmers and landowners of the State. Readers interested in having soil tested may get information from their county agricultural agent or the Soil Testing Service at the university.

Farm manure.—Well-cared-for farm manure is a valuable source of plant nutrients and organic matter. A ton of average fresh farm manure contains about 10 pounds of N, 5 pounds of P_2O_5 and 10 pounds of K_2O . Thus, 8 tons of manure an acre is equivalent in plant nutrients to applying 800 pounds of 10-5-10 fertilizer. The feeding of crops to livestock on the farm and use of manure is an efficient and usually profitable way to recover from crops a high percentage of the plant nutrients they have taken from the soil. In the form of farm manure, these nutrients can be returned to the soil and used again by crops.

Approximately 75 percent of the nitrogen, 85 percent of the potassium, and 65 percent of the phosphorus in the feed consumed by milk cows passes on into the manure (liquid and solid). These percentages are even higher for horses, sheep, hogs, and nonmilking cattle. Manure also improves soil structure and tilth, particularly in coarse-textured and fine-textured soils. It is likely that sustained, efficient agricultural production at a high level of output will be first attained on most soils of these counties by farmers who practice a sound system of feed crop and livestock farming. They will use lime and fertilizer according to soil needs, and much of the fertility removed by crops will be returned to the soil in the manure produced by livestock.

Lime.—When applied to acid soils, lime has several important effects. It neutralizes some of the soil acidity and adds calcium and magnesium, two important plant nutrients sometimes deficient in acid soils. By the use of lime, the soil reaction can be adjusted to about pH 6.5, which is the optimum for plant nutrient availability. Lime is especially important when phosphate fertilizers are applied to acid soils; it also promotes the activity of soil micro-organisms.

Most of the soils of Montour and Northumberland Counties are medium to very strongly acid and have rather large amounts of reserve acidity. Such soils require rather large applications of lime, especially for legumes. Some soils of this area, however, have clays of rather low exchange capacity. There may be some danger from overliming soils of this kind, particularly when the total clay content and supply of organic matter are low. Consequently, the safest method for determining the amount of lime to use is to send a sample to the soil testing laboratory at Pennsylvania State University for analysis and recommendations.

SOIL MANAGEMENT GROUPS

Soils much alike in properties that affect their agricultural use can be placed in groups, and such groups then have similar management requirements and can be studied together. The soils of Montour and Northumberland Counties have been placed in nine groups, several of which have one or more subgroups. The members of each subgroup

are sufficiently alike in important physical and chemical characteristics to have similar capabilities for use and to require similar crop rotations, fertilizer and lime applications, tillage methods, and other management practices.

Management groups are also useful guides for relocating boundaries that have proven unsatisfactory because they place widely different soils within one field. For example, the inspection of a given farm on the soils map and study of the classification of soils by management groups usually shows a pattern of similar soils that can be used as a guide for establishing field boundaries. Many good farmers have already recognized pronounced differences among soils on their farms and therefore placed them in different fields.

The soils were classified and grouped by soil scientists, extension workers, and experiment station personnel. The experience of farmers who had been interviewed was considered carefully in making the groupings.

It is recognized that the use and management practices recommended in this report for each management group may change in the future, for more knowledge will become available and the need for productive land will increase. The farmer can keep up with the latest scientific information on handling crops and soils by referring from time to time to the publications on crops and soils published by the State Agricultural Experiment Station, the State Agricultural Extension Service, and the United States Department of Agriculture.

MANAGEMENT GROUP 1

In management group 1 are deep well-drained soils on undulating to gently rolling slopes. They differ from each other in some profile features but have other characteristics in common that make them similar in agricultural use and management. Suitable crop rotations and fertilizer needs are listed for these soils in table 5.

The soils have adequate air and water relations and, except for the cherty phases, are easily tilled. Erosion can be controlled by use of suitable crop rotations and the application of fertilizer and lime to improve the vigor of crop growth.

The soils of management group 1 are some of the best in the two counties for tilled crops. Most of them, however, require lime and fertilizer for satisfactory crop growth. In most cases the unfertilized soils are so short in phosphorus and available nitrogen that crop production is seriously restricted. The sandy soils require relatively large amounts of potassium; the others require smaller amounts. On the gentle slopes, a 4-year rotation that provides a legume or grass cover at least 25 percent of the time is usually adequate to control erosion. In most places, however, it is believed that even these less sloping soils should be in a sod crop or legume at least a third of the time. Supplies of organic matter are rather low and should be replenished periodically by growing either sod or green-manure crops.

The soils of group 1 have been placed in three management subgroups, each of which is separately discussed.

Subgroup 1A.—These soils have developed on calcareous materials. Calcium carbonate has disappeared from the upper horizons as a result of leaching, but the lower subsoil is well supplied with lime. Alfalfa and other deep-rooted legumes are especially well adapted. Some of these soils require small amounts of lime for best growth of legumes.

TABLE 5.—*Management group 1: Suitable crop rotations and fertilizer needs for undulating and gently rolling deep and moderately deep well-drained soils of the uplands and terraces, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amount of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Suitable rotations ¹	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
1A. Soils with good drainage chiefly from calcareous materials:	Percent				
Elliber cherty silt loam.....	4-12	Corn, oats, alfalfa for 2 years. Corn, oats, red clover and timothy for 2 years. Corn, oats, wheat, alfalfa for 2 years. Corn, corn, oats, alfalfa for 2 years. Corn, oats, wheat, red clover and timothy for 2 years.	Nitrogen, phosphorus, potassium.	Apply according to soil test.	Plant in strips on the contour. Use lime and fertilizers according to test. Most soils respond to side dressings of nitrogen for corn and to top dressings of nitrogen for oats and wheat. Use 6 to 10 tons an acre of barnyard manure on fields to be planted to corn or vegetables.
Mazeppa silt loam.....	3-12				
Mertz cherty silt loam.....	3-8				
Eroded phase.....	3-8				
Mifflinburg silt loam.....	3-8				
Eroded phase.....	3-8				
Ryder silt loam.....	3-8				
Sedan cherty silt loam.....	3-8				
Eroded phase.....	3-8				
Sedan gravelly silt loam, eroded phase.	3-8				
Washington gravelly silt loam.	2-8				
Eroded phase.....	2-8				
Washington silt loam.....	2-8				
Eroded phase.....	4-8				

1B. Soils with good drainage chiefly from acid materials:					
Allenwood gravelly silt loam.....	3-12	Corn, oats, alfalfa for 2 years. Corn, oats, wheat, alfalfa for 2 years. Corn, oats, red clover and timothy for 2 years. Potatoes, oats, red clover and timothy for 2 years.	Same as for subgroup 1A.	Same as for subgroup 1A.	Same as for subgroup 1A.
Allenwood silt loam.....	3-12				
Eroded phase.....	3-12				
Dewart gravelly silt loam.....	3-12				
Dewart sandy loam, eroded phase.....	4-10				
Dewart silt loam.....	3-12				
Elkinsville silt loam.....	0-5				
Norton gravelly loam.....	3-12				
Eroded phase.....	3-12				
Norton silt loam.....	3-12				
Eroded phase.....	3-12				
Rebuck silt loam.....	3-10				
Eroded phase.....	3-10				
Stephensburg shaly silt loam.....	3-12				
Eroded phase.....	3-12				
Trexler channery silt loam.....	3-12				
Eroded phase.....	3-12				
Trexler gravelly silt loam.....	3-12				
Wheeling loam.....	0-12				
1C. Well to excessively drained soils of the terraces chiefly from acid materials:					
Chenango gravelly loam.....	0-8	Vegetable crop, ryegrass cover crop. Vegetable crop, wheat, red clover and timothy for 2 years. Corn, oats, red clover and timothy for 2 years.	Same as for subgroup 1A.	Same as for subgroup 1A.	Use of winter cover crops or return of crop residues is necessary to prevent blowing and to maintain organic matter.
Chenango sandy loam.....	0-8				
Lakin loamy fine sand.....	3-12				
Wheeling sandy loam.....	0-12				

¹ In these rotations rye, barley, or wheat can be substituted for oats; and soybeans, beans, or other vegetable for corn.

Most of the soils are not well adapted to potatoes but are well suited to soybeans, beans and tomatoes. The Elliber, Mertz, and Sedan soils are particularly well suited to pears, peaches, and apples.

Subgroup 1B.—These soils have developed from noncalcareous material derived from sandstone, shale, and quartzite. They are lower in fertility than the soils of subgroup 1A. Their supply of organic matter is slightly lower and they require considerably more lime and fertilizer than soils of subgroup 1A.

The addition of lime and fertilizers is necessary in order to grow deep-rooted legumes, and these legumes are needed to improve soil tilth and to replenish organic matter. Lime should be applied in accordance with the results of soil tests. Consideration should be given to application of some lime at plow depth in order to get it into the acid soil beneath the plow layer. Deep applications of lime, together with liberal amounts of phosphatic fertilizer, would make the soils more favorable for root penetration. These soils are suitable for the crops normally grown in this section but yield somewhat less than those of subgroup 1A.

Subgroup 1C.—In this subgroup are moderately coarse-textured to coarse-textured excessively drained soils that have a low moisture-holding capacity and are consequently somewhat droughty for certain crops.

The maintenance of soil fertility and organic-matter content is one of the most important problems. Heavy fertilization at frequent intervals—application of fertilizer for each crop—is usually necessary. The problem of supplying organic matter and reducing leaching of nutrients can be partly solved by using cover crops in fall and winter following vegetable crops. The cover crops also reduce soil losses caused by wind erosion. Also, a legume-grass mixture for 1 or 2 years should be a part of the rotation. These measures will aid in maintaining organic-matter content and improve water and plant-nutrient relations for these soils.

MANAGEMENT GROUP 2

In management group 2 are deep and moderately deep well-drained soils of the uplands and terraces on rolling to hilly slopes. The phases in this group are members of the same series as the soils of management group 1; consequently, the main differences between soils of group 1 and 2 are those arising from differences in slope.

Suitable crops are essentially the same as for management group 1, but intertilled crops should be grown less frequently and close-growing crops, particularly legumes and grasses, more frequently. Thought might well be given to use of rotations that include 3 to 5 years of meadow or pasture. Such rotations are best adapted to the feed-and-livestock type of farm, which is the type most common in the two counties.

The erosion hazard is greater; consequently, these soils have been more severely eroded than those of management group 1 and the A horizon remaining is usually shallower. Planting alternate strips of intertilled crops and close-growing crops should be practiced where the slopes are simple enough to permit. On complex slopes, erosion can be controlled by using close-growing crops more frequently in the rotation and applying generous amounts of fertilizer, lime and manure.

Fertility levels are generally low. To get maximum crop yields, nitrogen, phosphorus, and potassium ordinarily must be added in the form of fertilizer or manure. Suitable rotations for soils of management group 2, and their fertilizer needs, are shown in table 6.

Subgroup 2A.—The soils of this subgroup are mostly eroded phases that have slopes ranging from 8 to 20 percent. Controlling erosion and restoring and maintaining fertility are important problems. Legumes or legume-grass mixtures should make up at least one-third to one-half of the rotation. Alfalfa and the clovers are adapted to these soils.

Subgroup 2B.—These soils are similar to those of subgroup 1B except for having greater slopes—mostly slopes of 12 to 20 percent. From the soils of subgroup 2A, which developed on calcareous materials, they differ in being lower in lime and organic matter.

Management practices are much like those for soils of subgroup 2A but maintenance of organic matter is more of a problem and the need for lime and fertilizer is probably somewhat greater.

MANAGEMENT GROUP 3

Management group 3 is made up of undulating and gently rolling shallow and very shallow well-drained soils of the uplands and terraces that developed on both calcareous and noncalcareous parent materials.

Slopes range from 2 to 15 percent. Because of their shallowness, the soils are more subject to erosion and to drought than deep well-drained soils with similar slopes. The principal problems in management are improving and maintaining soil fertility and organic-matter content and controlling runoff and erosion. An effective means of controlling erosion is keeping legumes and grasses on the land at least one-third of the time during the rotation in conjunction with tillage on the contour. Table 7 lists the members of this group and suggests management practices for them.

Subgroup 3A.—In this subgroup are shallow and very shallow soils subject to erosion. Nevertheless, they grow clovers and alfalfa exceptionally well. Root penetration is favored by their permeable aerated subsoil, which is well supplied with lime. On most of these soils legumes do not need lime. The thinner eroded areas are best suited to a rotation consisting only of close-growing crops. For example, oats the first year, then wheat, and a legume-grass mixture for 2 years.

Subgroup 3B.—Members of this subgroup are acid and low in available calcium throughout the profile. Essential for good yields are applications of lime in amounts shown necessary by soil tests and the use of fertilizers containing nitrogen, phosphorus and potassium. The gravelly and channery soils are rapidly permeable to water and air and are consequently more droughty than the silt loams. Wheat is preferable to oats in the rotations used in these soils. The gravel in some of the Klinesville soils and the rock fragments in the Leck Kill channery soils affect workability, but not to serious extent.

MANAGEMENT GROUP 4

Rolling to hilly shallow and very shallow well-drained soils of the uplands and terraces are in management group 4. Slopes range from 8 to 20 percent, and extent of erosion seriously handicaps use of the

TABLE 6.—*Management group 2: Suitable crop rotations and fertilizer needs for rolling to hilly deep and moderately deep well-drained soils of the uplands and terraces, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amount of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Suitable rotations ¹	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
2A. Soils chiefly from calcareous materials:	Percent				
Elliber cherty silt loam, rolling phase.	12-20	Corn, oats, alfalfa and smooth brome- grass ² for 2 years. Corn, oats, wheat, alfalfa and smooth brome- grass for 2 years. ³ Corn, oats, red clover and timothy for 2 years.	Nitrogen, phosphorus, potassium.	Apply according to test.	Plant in strips on the contour for erosion control. Apply 6 to 10 tons of manure an acre on land to be planted to corn. Establish sod crops in natural waterways. Most soils respond to side dressings of nitrogen on corn and to top dressings of nitrogen on oats and wheat.
Mazeppa silt loam, eroded rolling phase.	12-20				
Mertz cherty silt loam:					
Eroded rolling phase ----	8-15				
Rolling phase -----	8-15				
Mifflinburg silt loam, eroded rolling phase.	8-18				
Sedan cherty silt loam, eroded rolling phase.	8-20				
Washington silt loam, eroded rolling phase.	8-15				

2B. Soils chiefly from acid materials:					
Allenwood gravelly silt loam, eroded rolling phase.	12-20	Silage corn, wheat, alfalfa, and timothy for 2 years. Silage corn, wheat, alfalfa, and timothy for 3 years. Corn, oats, red clover, and timothy for 2 years. Barley, alfalfa, and timothy for 3 years. ³	Same as for subgroup 2A.	Same as for subgroup 2A.	Same as for subgroup 2A.
Allenwood silt loam, eroded rolling phase.	12-20				
Dewart gravelly silt loam, eroded rolling phase.	12-20				
Norton gravelly loam:					
Eroded sloping phase-----	12-20				
Sloping phase-----	12-20				
Stephensburg shaly silt loam, eroded rolling phase.	12-20				
Trexler channery silt loam:					
Eroded rolling phase-----	12-20				
Rolling phase-----	12-20				
Wheeling sandy loam, eroded strongly sloping phase.	12-20				

¹ In these rotations rye, winter barley, or wheat can be substituted for oats, and soybeans, beans, or other vegetable crop for corn. Winter barley would be suitable only after silage corn.

² Timothy can be substituted for brome grass.

³ On the steeper slopes a rotation of this kind is preferable to the others listed for the subgroup.

TABLE 7.—*Management group 3: Suitable crop rotations and fertilizer needs for undulating and gently rolling shallow and very shallow well-drained soils of the uplands and terraces, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amount of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Suitable rotations ¹	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
3A. Soils chiefly from calcareous materials:	Percent				
Crestmore silt loam.....	3-8	Corn, oats, alfalfa for 2 years. Corn, oats, red clover and timothy for 2 years. Corn, oats, rotation pasture. ² Oats, wheat, red clover and timothy for 2 years. Barley, rotation pasture. ²	Nitrogen, phosphorus, potassium.	Apply according to test.	Plant in strips on the contour if possible. Fields with severe sheet erosion or gulying should be in grass and legumes at least half the time. Establish sod crops in natural waterways. Soils not suitable for orchards.
Eroded sloping phase....	8-15				
Hagerstown silt loam:					
Eroded shallow phase....	3-8				
Eroded sloping shallow phase.	8-15				
Kutztown shaly silt loam, gently sloping phase.	4-8				
Northumberland shaly silt loam, eroded phase.	3-8				

3B. Soils chiefly from acid materials:

Hartleton channery silt loam.....	3-12	Corn, oats, alfalfa for 2 years. Corn, oats, red clover and timothy for 2 years. Oats, wheat, red clover and timothy for 2 years. Wheat, rotation pasture for 3 to 5 years. Silage corn, wheat, rotation pasture for 3 to 5 years.	Same as for subgroup 3A.	Same as for subgroup 3A.	Same as for subgroup 3A.
Eroded phase.....	3-12				
Kistler shaly silt loam.....	2-12				
Eroded phase.....	2-12				
Klinesville gravelly silt loam:					
Eroded undulating phase.....	3-12				
Undulating phase.....	3-12				
Klinesville shaly silt loam:					
Eroded undulating phase.....	3-12				
Undulating phase.....	3-12				
Leck Kill channery silt loam.....	3-12				
Eroded phase.....	3-12				
Rushtown shaly silt loam.....	3-12				
Trexler channery loam.....	3-12				
Eroded phase.....	3-12				
Weikert channery silt loam.....	2-12				
Weikert shaly silt loam.....	3-12				
Wheeling silt loam, eroded shallow phase.....	3-12				

¹ In these rotations rye, barley, or wheat can be substituted for oats, and brome grass or orchard grass for timothy.² Grasses and legumes suitable for rotation pastures include alfalfa, timothy, Ladino white clover, and orchard grass.

soils. Erosion has been serious on nearly all the soils. Obtaining continuous productivity at satisfactory levels requires regular use of crop rotations that include intertilled crops only at infrequent intervals. Among other essential practices are the use of lime, particularly on the soils of subgroup 4B, and the intelligent use of commercial fertilizers and farm manure.

Contour and strip-crop planting will aid in reducing losses of water and soil. Areas with severe gulley or sheet erosion should be planted to permanent pastures.

Farms with fields made up largely of these soils might well be used principally for small grains, hay, and pasture grasses, which would be fed to livestock on the farm. Such use would facilitate control of runoff and attendant erosion and make maintenance of fertility easier. The members of this group and suggested management practices are shown in table 8.

Subgroup 4A.—The soils of this subgroup have developed from calcareous material. They are well supplied with calcium in the subsoil, and it is seldom necessary to apply lime for alfalfa or clovers. Maintaining supplies of organic matter is not difficult, for if phosphate and potash fertilizers are applied, these soils are adapted to legumes and grasses, plants that are good sources of organic material.

Subgroup 4B.—Members of this group have developed chiefly from acid parent materials; consequently, they have a rather high lime requirement. Supplies of organic matter need to be increased and maintained through the use of mixed legumes and grasses, the incorporation of all crop residues, and the use of farm manure. All the members of this group respond to phosphate, potash, and nitrogen fertilizers. The rock fragments and gravel in the Weikert members of this subgroup do not seriously interfere with tillage.

MANAGEMENT GROUP 5

In management group 5 are imperfectly and poorly drained soils of the uplands and terraces that have developed from calcareous and noncalcareous parent materials. The relief is mostly nearly level to undulating, though some phases of the Watson, Warrior, Comly, and Turbotville soils have a greater slope gradient.

The imperfectly drained soils of this group are suitable for most of the field crops climatically adapted to the area except alfalfa. Alfalfa is an uncertain crop because of the possibility that there will be a high water table in some seasons. The poorly drained soils are not suitable for tilled crops. See table 9 for crop rotations suitable for these soils.

Subgroup 5A.—Soils of this subgroup are slightly to medium acid in the surface soil and slightly acid to neutral in the subsoil. The Wiltshire soil does not need lime for clovers. Phosphate fertilizers are needed for all soils of this subgroup.

Subgroup 5B.—All soils of this subgroup are exceptionally acid. They require heavy initial applications of lime before clovers can be grown satisfactorily. The Warrior and Watson soils of this subgroup are subject to seepage from higher levels.

Subgroup 5C.—Soils of this subgroup have developed chiefly from acid materials. They are poorly drained and therefore suitable only for pasture grasses and legumes. Pastures or meadows ordinarily

will be improved by ditch drainage or drainage terraces. Lime and fertilizers are necessary to obtain suitable yields of pasture grasses and legumes. The Shelmadine, Bartle, Comly, and Ginat soils require artificial drainage for best results, but when drained and fertilized, can be used for all the common field crops except alfalfa. Undrained areas are suitable only for pasture grasses.

MANAGEMENT GROUP 6

In management group 6 are the well-drained and imperfectly drained soils of the bottom lands. They are usually deep, permeable, and easily tilled. The degree of drainage and the susceptibility to overflow largely determine their suitability for crops and pasture. Slopes are gentle and soil erosion is not a hazard. Some of the most productive vegetable and truck farms are located on the well-drained soils of this group. Areas subject to ponding are usually easily drained by ditching. See table 10 for crop rotations suitable for these soils.

Subgroup 6A.—Soils of this subgroup are deep and well drained. They have favorable moisture relations and a fair to good supply of organic matter. In fields where flooding is not likely to occur, they are particularly well suited to corn, wheat, oats, soybeans and alfalfa. Where the fields are periodically overflowed, alfalfa, red clover, and fall-sown grains cannot be depended on. Vegetables are well suited to some areas above overflow if phosphate and potash fertilizers are used liberally. Nitrogen is also needed where the organic-matter content is low.

Subgroup 6B.—The imperfect drainage of these soils makes them unsuitable for alfalfa and vegetable crops. If ditch drainage is provided for the ponded areas, corn, wheat, oats, alsike and red clovers, and timothy can be grown. These soils are especially productive of hay and pasture if properly limed and fertilized. Fertilizers containing nitrogen, phosphorus, and potash are needed to obtain satisfactory yields of most crops.

MANAGEMENT GROUP 7

Management group 7 is made up of poorly drained soils of the bottom lands. Unless they are artificially drained, these soils are not suited to tilled crops. After drainage, the Dunning, Holly, and Melvin soils are fairly productive of corn, oats, clovers, and the adapted grasses. Undrained areas, if not ponded, can be made into productive meadows or improved pastures.

Included in this group is Schuylkill silt loam, which has a large quantity of coal screenings in the upper part of the profile.

Suitable practices for the soils of management group 7 are outlined in table 11.

MANAGEMENT GROUP 8

Management group 8 consists of steep and very steep shallow well-drained soils of the uplands and terraces. Slopes range from 15 to 70 percent. Steep slopes and thinness make the soils unsuitable for tilled crops. Also, the soils are droughty and many of them have gravel, rock fragments, or chert that interfere with cultivation. Forested areas should remain forested, and severely gullied areas should be reforested.

TABLE 8.—*Management group 4: Suitable crop rotations and fertilizer needs for rolling to hilly shallow and very shallow well-drained soils of the uplands and terraces, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amount of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Suitable rotations ¹	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
4A. Soils chiefly from calcareous materials:	Percent				
Kutztown shaly silt loam:					
Eroded phase.....	12-20	Silage corn, wheat, rotation pasture. ²	Nitrogen, phosphorus, potassium.	Low; apply according to test.	Till on the contour. Establish sod in natural waterways. Use diversion terraces where needed. Soils not suitable for orchards.
Eroded sloping phase.	8-12	Silage corn, wheat, alfalfa and timothy for 2 years.			
Northumberland shaly silt loam, eroded rolling phase.	8-15	Wheat, red clover and timothy for 2 years. Wheat, alfalfa and timothy for 2 years. Permanent pasture ³ (for severely eroded areas).			

4B. Soils chiefly from acid materials:

Hartleton channery silt loam, eroded rolling phase.	12-20	Silage corn, wheat, red clover and timothy for 2 years. Wheat, alfalfa and timothy for 2 years. Wheat, red clover and timothy for 2 years. Corn, wheat, rotation pasture. ² Permanent pasture ³ (for severely eroded areas and on extreme slopes).	Same as for subgroup 4A.	Same as for subgroup 4A.	Same as for subgroup 4A.
Kistler shaly silt loam:					
Eroded rolling phase-----	12-20				
Rolling phase-----	12-20				
Klinesville gravelly silt loam, eroded phase.	12-20				
Klinesville shaly silt loam, eroded phase.	12-20				
Leck Kill channery silt loam, eroded rolling phase.	12-20				
Rushtown shaly silt loam, eroded rolling phase. ⁴	12-25				
Weikert channery silt loam:					
Eroded rolling phase-----	12-20				
Rolling phase-----	12-20				
Weikert shaly silt loam:					
Eroded rolling phase-----	12-20				
Rolling phase-----	12-20				
Wheeling silt loam, eroded strongly sloping shallow phase.	12-20				

¹ In these rotations winter barley can replace wheat, and brome-grass or orchard grass can replace timothy.² Grasses and legumes suitable for rotation pastures include alfalfa, timothy, Ladino white clover, and orchard grass.³ Suitable grasses and legumes for permanent pasture include

Kentucky bluegrass, orchard grass, and white clover; birdsfoot trefoil may be worthy of trial.

⁴ This is classed as a deep soil, but its eroded condition and shaly silt loam texture make it droughty and give it properties similar to the other soils of the subgroup.

TABLE 9.—*Management group 5: Suitable crop rotations and fertilizer needs for imperfectly and poorly drained soils of the uplands and terraces, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amounts of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Suitable rotations ¹	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
5A. Imperfectly drained soils chiefly from calcareous materials:	Percent				
Chillisquaque silt loam.....	0-5	{ Corn, oats, wheat, red clover, and timothy for 2 years.	Nitrogen, phosphorus, potassium.	None.....	Use ditch drainage for occasional ponded areas. Soils not suitable for orchards.
Kreamer cherty silt loam:					
Eroded phase.....	2-8	{ Corn, oats, mixture of red clover, alsike clover, and timothy for 2 years.			
Eroded rolling phase ²	8-15				
Turbotville silt loam.....	1-6	{ Corn, oats, mixture of Ladino white clover and orchard grass as meadow for 2 to 4 years.			
Eroded gently rolling phase.	6-12				
Eroded phase.....	1-6				
Williamsburg silt loam.....	0-5				
Wiltshire silt loam.....	2-6	{ Permanent pasture or meadow. ³			

5B. Imperfectly drained soils chiefly from acid materials:					
Alvira silt loam.....	2-7	} Corn, oats, mixture of alsike clover, red clover, Ladino white clover, and timothy. ¹ Oats, mixture of alsike clover, red clover, and timothy. Permanent pasture or meadow. ³	Same as for sub-group 5A.	Apply lime according to test.	Use diversion terraces on long slopes. Graded planting. ⁴ Soils not suitable for orchards or alfalfa.
Pekin silt loam.....	0-3				
Sciotoville sandy loam.....	0-3				
Sciotoville silt loam.....	0-3				
Warrior gravelly silt loam:	3-8				
Eroded phase.....	3-8				
Eroded sloping phase.....	8-15				
Watson gravelly silt loam:	3-7				
Eroded phase.....	3-7				
Eroded sloping phase.....	7-12				
Strongly sloping phase....	12-25				
5C. Poorly drained soils chiefly from acid materials:⁵					
Bartle silt loam.....	0-3	} Pasture or meadow. ³	Same as for sub-group 5A.	Same as for sub-group 5B.	Use diversion drainage terraces. Soils not suitable for orchards.
Chilo loam.....	0-3				
Comly silt loam: ⁶					
Eroded phase.....	2-6				
Eroded sloping phase.....	6-12				
Dubois silt loam.....	2-7				
Ginat sandy loam.....	0-3				
Ginat silt loam.....	0-3				
Montgomery silty clay loam ⁷ ..	0-3				
Shelmadine silt loam.....	0-6				

¹ In these rotations rye, barley or wheat can replace oats, and soybeans can replace corn.

² This soil more sloping than other members of this group but its drainage class places it here.

³ Grasses and legumes suitable for permanent pasture include Kentucky bluegrass, orchard grass, and white clover; birdsfoot trefoil may be worthy of trial.

⁴ In graded planting, rows are given a 1 percent slope.

⁵ In some years fair yields of corn, oats, alsike clover, and timothy can be obtained on drained areas.

⁶ Comly soils are imperfectly drained, but because of their shallow surface soil and impervious subsoil, management requirements are more nearly like those of poorly drained soils.

⁷ This soil has developed from calcareous material.

TABLE 10.—*Management group 6: Suitable crop rotations and fertilizer needs for well and imperfectly drained soils of the bottom lands, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amounts of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Suitable rotations ¹	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
6A. Well-drained soils:	Percent				
Ashton fine sandy loam.	0-3	Corn, wheat, red clover.....	Nitrogen, phosphorus, potassium.	Apply according to test.	To prevent blowing plant winter cover crops on sandy loams that would otherwise be bare.
Ashton silt loam.....	0-3	Corn, corn, oats, alfalfa for 2 years.			
Huntington sandy loam. ²	0-3	Corn, oats, alfalfa for 2 years...			
Huntington silt loam ² .	0-3	Corn, oats, red clover and timothy for 2 years.			
Tioga sandy loam.....	0-3	Corn, oats, alsike clover and timothy for 2 years.			
Tioga silt loam.....	0-3	Vegetable crop, ryegrass cover crop, vegetable crop, oats, red clover and timothy for 2 years.			
6B. Imperfectly drained soils:					
Lindside sandy loam..	0-3	{ Corn, oats, mixture of red clover, alsike clover and timothy for 2 years. Permanent pasture. ³	Same as for subgroup 6A.	Same as for subgroup 6A.	Not suitable for alfalfa or vegetable crops. Poned areas need terrace drainage.
Lindside silt loam.....	0-3				
Middlebury silt loam..	0-3				
Senecaville silt loam...	0-3				

¹ Soybeans can substitute for corn in these rotations, and wheat for oats. Wheat follows corn best when the corn is cut for silage.

² Some areas of Huntington soils mapped in these counties are frequently flooded.

³ Grasses and legumes suitable for permanent pasture include Kentucky bluegrass, orchard grass, and white clover; birdsfoot trefoil may be worthy of trial.

TABLE 11.—*Management group 7: Suggested use for poorly drained soils of the bottom lands, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amounts of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Soil type or phase	Dominant slope range	Most suitable use	Plant nutrients likely needed as fertilizers	Need for lime	Suggested supplemental practices and comments
Dunning silty clay loam.....	Percent 0-3	<i>Artificially drained areas:</i> Corn, oats, alsike and timothy for 2 years. <i>Undrained areas:</i> Corn, oats, red clover for 2 years. Meadow or improved pasture. ²	Nitrogen, phosphorus, potassium.	Apply according to test.	Ditch drainage of those soils suited to cultivation.
Holly silt loam.....	0-3				
Melvin sandy loam.....	0-3				
Melvin silt loam.....	0-3				
Schuylkill silt loam ¹	0-3				

¹ Schuylkill silt loam has imperfect rather than poor drainage, but was placed with this group of poorly drained soils because of similarity in management requirements. It is in native forest.

² Grasses and legumes suitable for meadow or improved pasture include Kentucky bluegrass, orchard grass, Ladino white clover, and alsike clover.

TABLE 12.—*Management group 8: Suggested use for steep soils, Montour and Northumberland Counties, Pa.*

[Needs for fertilizer and lime are not constant even for a particular soil. Consider nature of the soil, cropping history, past fertilizer practices, amounts of manure used, and the crop to be grown. Applications of fertilizer and lime should be based on the results of soil tests. Information on how to obtain soil tests can be obtained from your county agricultural agent or from the Soil Testing Service, Pennsylvania State University]

Subgroup and soil type or phase	Dominant slope range	Most suitable use	Plant nutrients likely needed as fertilizers	Need for lime
8A. Soils chiefly from calcareous materials:	Percent			
Crestmore silt loam, eroded hilly phase.	15-30	<i>Forested areas:</i> Leave in forest. <i>Cultivated areas:</i> If not severely gullied, seed to permanent pasture consisting of mixed grasses and a legume. Plant severely gullied areas to trees. <i>Areas that must be cultivated:</i> Wheat, red clover and timothy for 2 years. Wheat, orchard grass and timothy and Ladino white clover for 2 to 4 years.	Nitrogen, phosphorus, potassium.	Apply according to tests.
Elliber cherty silt loam, hill phase.	20-40			
Hagerstown silt loam, eroded hill shallow phase.	15-40			
Kreamer cherty silt loam, eroded hilly phase.	15-25			
Kutztown shaly silt loam, erode hill phase.	20-35			
Mertz Cherty silt loam, eroded hill phase.	15-30			
Northumberland shaly silt loam, eroded hill phase.	15-35			

TABLE 13.—Management group 9: Suggested use of management for rough stony soils, and very steep soils, Montour and Northumberland Counties, Pa.

Soil type, phase, or miscellaneous land type	Dominant slope range	Most suitable use	Suggested supplemental practices and comments
	<i>Percent</i>		
Buchanan stony loam.....	4-20	Forestry.....	Prevent burning and prohibit grazing in forested areas. Plant open areas to adapted species. Practice approved cutting methods.
Fleetwood channery loam, shallow phase.....	5-12		
Fleetwood stony loam.....	12-20		
Gently rolling phase.....	5-12		
Hilly phase.....	20-35		
Shallow phase.....	12-35		
Klinesville stony loam.....	5-60		
Leetonia stony loamy coarse sand.....	5-25		
Lickdale stony silt loam.....	2-6		
Lycoming stony loam.....	10-25		
Natalie stony silt loam.....	4-10		
Rough stony land:			
Dekalb soil material.....	3-60+		
Weikert soil material.....	70+		
Springtown stony loam, hill phase.....	20-35		
Trexler channery loam, steep phase.....	20-50		
Watson stony loam.....	5-12		
Strongly sloping phase.....	12-28		
Weikert channery silt loam, very steep phase.....	50-70		
Weikert flaggy loam.....	5-20		

With few exceptions, the cultivated areas that are not severely gullied should be worked down to a good seedbed, limed, fertilized, and sown to a combination of grasses and legumes. Where such areas have to be cultivated, only close-growing crops should be used. See table 12 for suggested management of these soils.

Subgroup 8A.—The Elliber and Kreamer members of this subgroup are well suited to orchards. Areas having relief near the lower limit of the slope range that are not severely gullied and have had only moderate erosion can be managed in a rotational pasture or meadow scheme that includes an occasional crop of small grain.

Subgroup 8B.—In this subgroup are many hilly and steep areas of Weikert, Kistler, and Klinesville soils that were once cultivated. Because of active erosion and the depletion of fertility, most of these areas have now reverted to nearly worthless pasture or lie idle. Some areas have reverted to forest, the use to which soils of this group are best suited, but the forest comes back very slowly.

Where areas of these soils must be included as cropland, rotational pasture or meadow crops should be established. An occasional crop of wheat or winter barley can be obtained on areas of these soils having relief near the lower limit of the slope range.

MANAGEMENT GROUP 9

Most of the rough stony and very steep soils of management group 9 occur in the mountains. Slopes are extremely variable, ranging from 2 to more than 70 percent. The areas with moderate slopes are too stony for cultivation and are therefore classed with the steep soils, which are suitable only for forestry. Suggested management for soils of this subgroup are given in table 13.

ESTIMATED YIELDS

Estimated average acre yields of principal crops to be expected on the soils of Montour and Northumberland Counties are given for each soil in table 14. These estimates are based on the experience of staff members of the Pennsylvania State University and Agricultural Experiment Station, the observations made by the survey party, and interviews with farmers. The level of management assumed in making these estimates was that used by most farmers in the two counties at the time of survey.

The estimates do not apply to any specific farm in any particular year, for management differs somewhat from farm to farm, a soil varies to some extent from place to place, and weather fluctuates from year to year. For example, yields in years of favorable rainfall probably will be greater than given in table 14, whereas those in years of drought will be less. The yields in table 14 therefore are those to be expected on given soils over a period of time.

The yields in table 14 do not indicate the response soils will make when better management than that commonly followed by most farmers in the two counties is applied. Limited experimental tests on a few soils in this State, some of them similar to soils in these counties, indicate that yields on many soils can be increased considerably above those given in table 14. Increases in yields on a sustained basis will require intelligent application of the principles of soil use and management discussed in this report.

Ginat sandy loam.....	23	10	20	0.7				11	Fair	55	10	15	20	50
Ginat silt loam.....	25	10	22	0.9				13	do	50	15		35	50
Hagerstown silt loam:														
Eroded hill shallow phase.....	28	12	19	1.0	1.5				Good	50	10	10	30	8A
Eroded shallow phase.....	38	17	26	1.4	2.0	110			do	90	8		2	3A
Eroded sloping shallow phase.....	33	14	20	1.3	1.9				do	70	5		25	3A
Hartleton channery silt loam.....	34	15	23	1.1	1.6	110	180		do	50	5	5	40	3B
Eroded hilly phase.....	25	12	18	.8				15	do	80	10	10		8B
Eroded phase.....	33	14	22	1.0				12	Fair	100				3B
Eroded rolling phase.....	32	14	23	1.0	1.4	105	165	14	do	60	10	5	25	4B
Hilly phase.....	28	14	20	.8				13	do	10			90	8B
Holly silt loam.....	17			.6					Poor	25	35	20	20	7
Huntington sandy loam.....	43			1.3	1.8				Good	80			20	6A
Huntington silt loam.....	54	20	30	2.0	2.8	110		20	do	90	5		5	6A
Kistler shaly silt loam.....	28	12	21	.9	1.3	75		13	Fair	65	10	10	15	3B
Eroded hilly phase.....	19	8	14	.6	0.9	50		9	Poor	40	20	20	20	8B
Eroded phase.....	26	11	19	.8	1.2	70		12	Fair	80	10	10		3B
Eroded rolling phase.....	24	10	18	.8	1.1	65		11	do	80	10	10		4B
Hilly phase.....	19	8	14	.6	0.9	50		9	Poor				100	8B
Rolling phase.....	26	11	19	.8	1.2	70		12	Fair				95+	4B
Klinesville gravelly silt loam:														
Eroded hill phase.....	13			.4					Poor	65	5	15	15	8B
Eroded phase.....	17	8	13	.7	1.1				Fair	85	5	5	5	4B
Eroded undulating phase.....	18	9	14	.7	1.2				do	90	5	5		3B
Undulating phase.....	20	10	15	.8	1.2				do	90	5	5		3B
Klinesville shaly silt loam:														
Eroded hill phase.....	13			.4					Poor	70		15	15	8B
Eroded phase.....	17	8	13	.7	1.1				Fair	80	5	5	10	4B
Eroded steep phase.....	12			.4					Poor	60	10	15	15	8B
Eroded undulating phase.....	19	9	15	.8	1.2	65			Fair	90	5	5		3B
Undulating phase.....	20	10	15	.8	1.2				do	75			25	3B
Klinesville stony loam.....													90+	9
Kreamer cherty silt loam:														
Eroded hilly phase.....	31	12	22	.8	1.4			12	Good	70	15		15	8A
Eroded phase.....	40	16	28	1.1	1.8	120	205	16	do	90	3	2	5	5A
Eroded rolling phase.....	33	12	23	1.0	1.5	90	165	15	do	85	5	5	5	5A
Kutztown shaly silt loam:														
Eroded hill phase.....	17	10		.8	1.3			12	Fair	70	15	10	5	8A
Eroded phase.....	26	12	21	.8	1.2			13	Good	85	5	5	5	4A
Eroded sloping phase.....	27	13	22	.8	1.2			14	do	70	15	10	5	4A
Gently sloping phase.....	29	14	23	1.0	1.5			15	do	70	15	10	5	3A
Lakin loamy fine sand.....	33			.7					Fair	95+				1C
Leck Kill channery silt loam.....	34	15	23	1.1	1.6	110	180	15	Good	70	3	2	25	3B
Eroded hilly phase.....	28	12	20	.8	1.2			11	Fair	75	5		20	8B
Eroded phase.....	33	14	22	1.1	1.6	105	170	14	Good	50	10	10	30	3B
Eroded rolling phase.....	32	14	21	1.0	1.5	100	160	13	do	75	5		20	4B
Leetonia stony loamy coarse sand.....													100	9
Lickdale stony silt loam.....													100	9
Lindside sandy loam.....	37			1.5					Good	60			40	6B
Lindside silt loam.....	40			1.7					do	45	30	5	20	6B
Lycoming stony loam.....													100	9

See footnotes at end of table.

Rushtown shaly silt loam	35	14	24	1.0				17	Good	70	5	10	15	3B
Eroded rolling phase	31	13	22	0.9				15	Fair	95			5	4B
Ryder silt loam	42	19	27	1.3	2.2	115		17	Good	100				1A
Schnykill silt loam *												10	90	7
Sciotoville sandy loam	28	12	23	0.8				14	Good	85	5	5	5	5B
Sciotoville silt loam	35	15	28	1.1	1.2	85		15	do	85	5	3	7	5B
Sedan cherty silt loam	43	16	28	1.1	2.3	120		16	do	95	5			1A
Eroded phase	40	14	25	1.0	2.0	100		14	do	100				1A
Eroded rolling phase	38	14	24	1.0	2.0	95		14	do	100				2A
Sedan gravelly silt loam, eroded phase	40	17	30	1.3	2.5	120		16	do	100				1A
Senecaville silt loam *	28		25	1.1					do	65	15	5	15	6B
Shelmadine silt loam	22	12	22	0.8				11	Fair	50	5	15	30	5C
Springtown stony loam	28			.8					Poor	15		5	80	8B
Hill phase										20			80	9
Stephensburg shaly silt loam	35	16	25	1.0	1.5	100	180	15	Good	40	5	10	45	1B
Eroded hilly phase	22	12	18	.7					Fair	85	5	10		8B
Eroded phase	30	16	24	1.0	1.5	95	175	15	Good	85	10	5		1B
Eroded rolling phase	28	15	23	.9	1.4	95	175	15	Fair	70	10	10	10	2B
Tloga sandy loam *	44	19	28	1.2	2.3			17	Good	100				6A
Tloga silt loam *	48	21	30	1.3	2.5			18	do	100				6A
Trexler channery loam	28	11	18	.8				13	Fair	35	5	5	60	3B
Eroded phase	27	10	17	.7				12	do	90	5	5		9
Steep phase													100	9
Trexler channery silt loam	36	15	26	1.1				14	Good	55	2	3	40	1B
Eroded hilly phase	23	10	17	.7					Fair	55		15	30	8B
Eroded phase	35	15	25	1.1				13	Good	100				1B
Eroded rolling phase	29	12	21	.9				11	do	90	5	5		2B
Rolling phase	33	14	24	1.0				13	do	25		5	70	2B
Trexler gravelly silt loam	36	15	26	1.1				14	do	90			10	1B
Turbotville silt loam	48	20	30	1.5	2.6	110	190	18	do	95	5			5A
Eroded gently rolling phase	41	17	28	1.4	2.4	100	180	16	do	100				5A
Eroded phase	45	19	30	1.5	2.6	110	190	18	do	95	5			5A
Warrior gravelly silt loam	40	18	30	1.1	1.4	100		18	do	60	5	5	30	5B
Eroded phase	39	17	29	1.1	1.4	95		17	do	100				5B
Eroded sloping phase	36	16	27	1.0	1.3	90		16	do	5	50	10	35	5B
Washington gravelly silt loam	52	22	33	1.6	2.8	120	210	20	do	95+				1A
Eroded phase	48	21	31	1.5	2.7	115	200	19	do	100				1A
Washington silt loam	52	22	33	1.6	2.8	120	210	20	do	98	2			1A
Eroded phase	48	21	31	1.5	2.7	115	200	19	do	98	2			1A
Eroded rolling phase	47	20	30	1.4	2.6	110	190	18	do	98	2			2A
Watson gravelly silt loam	38	17	28	1.1	1.3	100		16	do	30	5	5	60	5B
Eroded phase	37	17	27	1.1	1.3	95		16	do	90	5			5B
Eroded sloping phase	35	16	26	1.0	1.2	90		15	do	70		10	20	5B
Strongly sloping phase	27	12	19	0.8	0.9	80		12	Fair	4	3	3	90	5B
Watson stony loam													100	9
Strongly sloping phase													100	9

See footnotes at end of table.

TABLE 14.—Average acre yields of the principal crops to be expected over a period of years under common management practices on each soil in Montour and Northumberland Counties, Pa., and land use at time of survey—Continued

Soils	Corn	Wheat	Oats	Mixed hay	Alfalfa	Potatoes ¹		Soybeans	Pasture ²	Land use at time of survey				Man- age- ment group or sub- group ³
						A	B			Estimated percentage in—				
										Crop- land	Pasture	Idle	Forest	
	<i>Bushels</i>	<i>Bushels</i>	<i>Bushels</i>	<i>Tons</i>	<i>Tons</i>	<i>Bushels</i>	<i>Bushels</i>	<i>Bushels</i>						
Welkert channery silt loam.....	30	14	23	1.0	1.7	70			Fair.....	50	5	15	30	3B
Eroded hilly phase.....	17	11	16	.6					Poor.....	75	5	20		8B
Eroded rolling phase.....	26	12	20	.9	1.5				Fair.....	75			25	4B
Eroded steep phase.....										50	10	35	5	8B
Hilly phase.....										10			90	8B
Rolling phase.....	28	13	22	1.0	1.6	65			Fair.....	45		10	45	4B
Steep phase.....													100	8B
Very steep phase.....													100	9
Welkert flaggy loam.....													95+	9
Welkert shaly silt loam.....	23	10	14	.8	1.2	70			Fair.....	45	5	20	30	3B
Eroded rolling phase.....	16	7	10	.5	1.5				Poor.....	75		20	5	4B
Rolling phase.....	20	9	12	0.7	1.0	65			Fair.....	50	8	7	35	4B
Wheeling loam.....	46	17	33	1.3	2.1	130	235	18	Good.....	100				1B
Wheeling sandy loam.....	40	14	30	1.1	1.6	115	190	15	do.....	100				1C
Eroded strongly sloping phase.....	37	13	26	1.0	1.6			14	do.....	100				2B
Wheeling silt loam:														
Eroded shallow phase.....	37	18	25	1.1	1.6			18	do.....	100				3B
Eroded strongly sloping shallow phase.....	35	16	23	1.0	1.5			16	do.....	75	5	15	5	4B
Williamsburg silt loam.....	40	17	30	1.3	1.7	100		16	do.....	85	10	2	3	5A
Wiltshire silt loam.....	40	16	30	1.3	1.7	100		16	do.....	67	33			5A

¹ Column A gives yields of potatoes mainly grown in small patches for home use. They commonly receive about 250 pounds of a 2-12-6 or similar fertilizer and are seldom sprayed. Column B gives yields of potatoes grown in larger fields for sale. They receive from 500 to 1,000 pounds of 5-10-5, 4-8-8, or similar fertilizers and are sprayed as required.

² Permanent pasture. Relative descriptive terms are used here because quantitative data are lacking.

³ Use management group or subgroup number in this column to locate suggested crop rotations and other management practices in the subsection on Soil Management Groups.

⁴ Yields for soils of the bottom lands are given only for areas unprotected by dikes or levees, as only one or two soils receive such protection.

WATER CONTROL ON THE LAND

In these counties water control on the land is restricted to control of runoff and providing artificial drainage. Neither irrigation nor control of flooding by dikes or similar structures is significant in the present agriculture. The areas requiring runoff control are mainly on the uplands, whereas those requiring drainage are largely confined to stream bottoms and flat terraces. Because about two-thirds of the land used for crops needs runoff control and a considerable part needs artificial drainage, both practices are agriculturally important.

CONTROL OF RUNOFF AND EROSION

The discussion in the subsection deals with the problems of controlling runoff and erosion in fields, pastures, and forests.

Most of the cleared land suitable for cultivation in Montour and Northumberland Counties has been cleared for 100 to 160 years. During much of this time erosion has been active. Failure to adjust use and management to the natural capabilities and requirements of the soils has been the principal cause of the active erosion. Perfect adjustments of land use and management to the natural character of the soils perhaps cannot be expected in the immediate future, but readjustments in soil use and management can be made that will control runoff, prevent serious erosion, and maintain or increase productivity.

The nature of the soil strongly influences erosion. A few of the soils of the area are porous and absorb rainfall and water from melting snow, but most of them are fine-textured and moderately dense and tend to shed water. Because the soils of this area are silty, the surface pores tend to seal and to interfere with the infiltration of surface water where the organic-matter content is low. Furthermore, some of the silt is easily picked up and carried away, even by gently flowing water. Some erosion occurs even on the gentle slopes of less than 5 percent unless they are fully protected by vegetation. Slope strongly affects the velocity of running water, and, other things being equal, velocity of flow determines the load of soil material running water can carry as well as the size of particles which can be moved. Soil material, slope, and cover act together either to accelerate soil erosion or to retard it.

Management practices for control of erosion and maintenance of soil fertility are discussed in the section on Use, Management, and Productivity of the Soils. For information on water and erosion control for a particular soil find that soil in the section on Descriptions of the Soils and read under the subheading *Use and Management*, which follows the description of each soil. Additional information on management for control of runoff and erosion will be found in the subsection on Soil Management Groups.

Runoff control is highly significant in the agriculture of the two counties because of the large eroded acreage and the many beneficial effects of control. Among the desirable effects brought about by runoff control are (1) a more equitable supply of moisture for growing crops; (2) improved tillage conditions, particularly in periods of low rainfall; (3) better conditions for biological activity; (4) improved

conditions for the formation of humus; and (5) erosion control. All of these, in turn, facilitate further conservation and control of water on the land.

DRAINAGE

At the time of the survey about 20 percent of the soils in the agricultural sections of Montour and Northumberland Counties needed artificial drainage. For most of this area, other soil improvements and amendments will not be very effective unless drainage is improved. Good soil drainage permits early development of the deep plant roots that can draw water and nutrients from a larger area later in the season. Tile drainage is useful to remove the excess or free water from the soil during spring months. Since the soil can then be worked sooner and the crops planted earlier in the season, a longer growing period is provided for those crops that require the maximum time to mature. Without underdrainage, surface erosion is more apt to occur. Tile and open-ditch drainage increase the water-absorbing capacity of medium to heavy soils and thus lessen surface runoff and erosion.

Installation of artificial drainage has been restricted in these counties by cost, which during the period preceding this survey was frequently greater than the increased value of crops that could be obtained thereby. If their capacity to produce crops is to be materially increased, however, all soils of the areas that have gray or mottled gray, yellow, and brown subsoil need better drainage.

Poorly drained soils.—In this group are the Lickdale and Shelmadine soils of the uplands; the Bartle, Chilo, Dubois, Ginat, and Montgomery soils of the terraces; and the Dunning, Holly, and Melvin soils of the bottom lands. Drainage practices are recommended for the particular soils in the subsection, Soil Management Groups, so only a general discussion of drainage will be presented here.

Installation of tile drains for the bottom land soils—Dunning, Holly, and Melvin—is generally a waste of time and money. A few open ditches are less expensive and nearly as effective. Drains in these soils fill rapidly during periods of overflow.

The Lickdale soil is best suited to forestry. Artificial drainage would not be justified by the increased return it would bring.

Ditch drainage and drainage terraces are recommended for the Dubois and Chilo soils. The main difficulty with the Chilo soil is providing outlets. Position, rather than subsoil texture, causes it to be poorly drained.

Ditch drainage and drainage terraces are recommended for Shelmadine, Bartle, Ginat, and Montgomery soils, but tile drainage is practicable. Ditch drainage really is not sufficient, as these soils have nearly level surfaces that retard runoff and a moderately heavy subsoil that makes natural underdrainage slow and difficult. For the Ginat and Shelmadine soils, tile lines laid at a depth of 36 inches and not more than 60 feet apart should give satisfactory results; experiments with tile laid in this way have been successful for soils similar to these. For good results on the heavier Montgomery and Bartle soils, the tile lines should not be more than 48 feet apart.

The preceding information on depth and spacing of tile applies for general farm crops in the two counties. Alfalfa, with its deep roots,

naturally should have a deeper drainage system. Wheat and other small grains will tolerate more shallow drainage. A fair depth for orchard drainage is generally 4 feet. On level areas tile should be carefully laid to obtain an even grade and uniform fall.

Except for the Lickdale, all these poorly drained soils can be used successfully for crops such as wheat, oats, red clover, corn, and soybeans if a good drainage system is installed. Pasture grasses also will benefit as a result of lowering of the water table. The proportion of white clover and Kentucky bluegrass in pastures would increase considerably on many poorly drained soils if the water table were lowered only 6 inches. Grasses fail to spread or root properly on saturated soils.

Imperfectly drained soils.—Classed as imperfectly drained are the Alvira, Buchanan, Comly, Kreamer, Natalie, Turbotville, Warrior, Watson, and Wiltshire soils of the uplands; the Chillisquaque, Pekin, Sciotoville, and Williamsburg of the terraces; and the Lindside, Middlebury, Schuylkill, and Senacaville of the bottom lands. The following discussion points out only general features of drainage for these soils. Specific recommendations will be found in the subsection on Soil Management Groups.

The advantage to be gained by artificial drainage differs among the soils of this group, for the individual soils differ in degree of natural drainage and in other soil characteristics pertinent to agriculture. Speaking in general terms, most of the soils produce fair yields of corn, oats, timothy and clover, and soybeans and good yields of pasture. Their use for alfalfa, fruit trees, and other exceptionally deep-rooted crops is extremely limited. The soils can be improved to some extent by open ditches and tile lines that will allow for deeper rooting of plants and removal of excess water sooner in spring and after long saturating rains. Under present farm management, it is doubtful that a complete system of tile drainage would be profitable. Straightening and deepening many of the sluggish drainageways would relieve some of the soils of excess water and curtail flooding. This is especially true for soils of the bottom land. The closer together drainage ditches are spaced, the more adequate and uniform the resulting drainage.

The Buchanan and Natalie soils, occurring in mountain areas, are too stony and low in fertility for cultivation, so draining them would be impractical. The Schuylkill soil is almost entirely in forest.

The Watson, Turbotville, and Kreamer soils have good drainage to depths of 20 to 30 inches in most places. After excess water is removed in spring, they generally remain in good condition for plant growth the rest of the growing season. Nevertheless, they are subject to considerable seepage from higher lying soils and have compact lower layers; it would be difficult to improve their drainage much by ordinary methods, and the improvement would be very costly in comparison with increased returns.

The Alvira, Chillisquaque, Pekin, Sciotoville, Williamsburg, and Wiltshire soils have drainage somewhat inferior to that of the Kreamer, Turbotville, and Watson soils. Below depths of 15 to 20

inches they remain saturated a large part of the year and root penetration is greatly restricted.

Diversion ditches on long slopes and graded planting are recommended for the Alvira, Comly, Pekin, Sciotoville, Warrior, and Watson soils; and ditch drainage of occasional ponded areas for the Chillisquaque, Kreamer, Turbotville, Williamsburg, Wiltshire, Lindside, Middlebury, and Senacaville soils.

FORESTS

The forests of Montour and Northumberland Counties may be classed in two main groups: (1) Those of the agricultural lowlands and (2) those of the mountain areas.

Agricultural lowlands.—The valleys are essentially agricultural, and most of them no doubt will remain so. Scattered throughout this farming section, however, are areas not suited to permanent agricultural use because of steep slope, shallow soil, poor drainage, or careless management in the past. Most of these areas are small and are part of some operating farm. Since they are better suited to forestry than to agricultural use, and since it is always desirable that a farm have a home supply of fuel wood, fencing, and repair materials, such land should be largely kept in timber and managed as farm forests for the continuous supply of these items.

In agricultural sections of the two counties, erosion usually can be controlled by other means than reforestation. Some hilly and steep areas, however, do not bring in sufficient income from crops to justify their use for that purpose. Many of these areas are very acid and shaly or stony, and pasture grasses do not thrive well. Soils with these characteristics should be used primarily for farm woodlots and forests.

Some of the areas of imperfectly drained soils, as of the Watson and Kreamer for example, occur on slopes of more than 12 percent and have been severely eroded. They could well be planted to forests. They are not especially adapted to pasture and pastures are difficult to establish.

Patches and blocks of shallow soils or soils on sloping areas throughout the two counties have been reseeded to forest trees. Pines and hemlocks apparently thrive better than other trees on old fields. The new stands of timber on such fields are composed largely of these trees. Permanent forests and wood lots in the agricultural sections are made up largely of red and white oaks, maple, yellow-poplar, hickory, red oak, elm, walnut, and sorghum.

Mountain areas.—The mountain areas in the two counties are essentially forest land. These include Montour Ridge north of the Susquehanna River and the mountains in the southern half of Northumberland County. A small part of these areas is in State forest.

The soils of the nonagricultural areas are largely developed from sandstone material that is only slightly influenced by shale. These areas, which include the mountain ridges and steeper slopes, are low in fertility, organic matter, and moisture-storing capacity. Near the base of the mountains where the soil material has collected to con-

siderable depth, better organic-matter content and moisture relations are indicated by the growth of larger trees and a larger proportion of white oak and maple.

The soils of the higher mountains are included with Rough stony land (DeKalb soil material) and the Leetonia soil. The lower slopes at the base of the mountains are principally occupied by the stony loam types of the Buchanan, Lickdale, Lycoming, Natalie, Norton, and Springtown series. These mountains, once covered by a vast virgin forest, passed through various stages of selective logging to almost destructive clear cutting, until by the year 1900 only a few small tracts of good timber and scattered trees remained. Most of the area thus logged was burned over subsequent to 1910, before forest protection really became operative.

At one time the conifers, mostly white pine and hemlock, prevailed on the lower slopes and foot hills of the mountains, and pitch pine in places on the mountain ridges. These species reproduce from seed. Destruction of the mother trees, followed by forest fires, destroyed the young growth as well as the natural seedbeds. Since the conifers could not reproduce prolifically, the hardwoods, reproducing by sprouts as well as by seed, took their place. In consequence, a Northern hardwood-oak type forest now predominates in these mountains. Because forest fires have covered only local areas since 1910, the average age of the timber is close to 30 years. It is still too young for intense utilization such as practiced on some of the older timber stands in the wood lots of the counties. Thinning is being practiced by the State and by a few owners of extensive tracts of timber land. Grazing is prohibited on State-owned land. Rough roads that can still be traveled by automobile or truck traverse most sections of the mountains, and every tract is within 2 miles of a road. The use of fire crews and fire towers has so reduced fires that they are no longer a serious menace.

The forest areas serve as recreation grounds for surrounding communities and towns. Deer, grouse, rabbits, and squirrels are fairly plentiful. Hunting lodges and camping and picnicking facilities are well developed.

In the agricultural sections it is a common practice to allow livestock to run in the woods, their owners believing that they can pick up some feed without doing any damage. This is not a good practice, especially on sloping areas. If the forest is dense, there is little grazing available. The livestock kill out the young growth and open up the forest so that the leaves blow away. The trampling hoofs compact the ground so that water runs off instead of soaking into the soil. If these farm-forest areas are to show a satisfactory return and contribute a reasonable share to the farm income, they must be fenced against grazing livestock and be cut according to practices recommended by the Forest Service.

In the limestone and limy shale sections wooded patches are small and consist largely of hardwoods. In the sections underlain by acid shales and having shallow acid soils, pines should make up a considerable part of the stand, particularly where abandoned farm land is to be artificially reforested. Pines require less fertile soil than most hardwoods, are easier to transplant, and grow more rapidly.

MORPHOLOGY AND GENESIS OF SOILS^{7 8}

Montour and Northumberland Counties are situated in the Ridge and Valley province of the Appalachian Highland. This province lies within the belt of Gray-Brown Podzolic soils, and the soils have developed chiefly under a deciduous forest in a moist, temperate climate. Small bodies of true Podzols also occur in the area; they have developed on the higher ridges in the mountains.

These two counties are in a section of the State where much soil diversity exists. Nevertheless, nearly all of the soils except those with impeded drainage are light in color and rather low in organic matter because they have developed under a forest cover, which is less favorable to accumulation of organic matter than a grass cover.

In considerable proportion the soils are on steep and precipitous slopes (30 to 70 percent and more). In these steep areas geologic erosion has been so active that the development of true soil characteristics has been greatly impeded; consequently, the soil characteristics are very closely related to the petrological features of the parent material and the substrata. It is estimated that one-fourth of the soils on smooth ridges and rolling and hilly areas are also shallow and not fully developed. About one-third of the soils occupy smooth terraces and undulating to rolling upland till areas, where soil-forming processes have not been impeded by excessive runoff or by imperfect or poor drainage. In these places true soil characteristics have been developed. Most of the alluvial soils are considered to be very young—so young that climate and vegetation have not had time to produce any material changes in the profile.

⁷ See Formation of Soil, By H. G. Byers, Charles E. Kellogg, M. S. Anderson, and James Thorp, *In* Soils and Men, U. S. Dept. Agr. Yearbook 1938, pp. 948-978.

⁸ When soil scientists mapped and correlated the soils of these counties in the early 1940's, they assumed that soil parent materials in the areas covered by the ice of the Jerseyan and Illinoian ice ages were, of necessity, more strongly weathered than parent materials covered by Wisconsin ice. They assumed that weathering took place during the long periods of time that elapsed between the various ice ages, last of which was the Wisconsin. Likewise, they reasoned that, within the area covered by any one ice sheet, practically all of the soils of the uplands must be weathered to about the same degree. The Allenwood soils, for instance, are demonstrably developed on pre-Wisconsin glacial drift. Adjacent to the Allenwood are the shallow shaly Welkert soils, so it seemed reasonable to assume that the Welkert soils also were influenced to some degree by the pre-Wisconsin ice sheets. On this basis, there could be no question that the parent materials of the Welkert soils were as old and as strongly weathered as those of the Allenwood.

Studies in the late forties and early fifties by Denny (Ohio Jour. Sci., v. 51, pp. 116-125) in this general area have shown that, very likely, frost action profoundly disturbed and moved the surface materials in the area just beyond the southern extremity of the Wisconsin ice sheet. Because of this frost disturbance, it is probable that some of the soils in areas covered only by the pre-Wisconsin ice sheets have developed on parent materials that are the same age as those in the area covered by the Wisconsin ice sheet. Thus, the Welkert parent material may not be nearly so old as once thought; it may have formed by the action of frost on the bedrock during Wisconsin time. None of the mantle that was on the rock during pre-Wisconsin time may have remained to become parent material for Welkert soil.

Thus, it may be necessary to review the basis used for classifying the soil series in Montour and Northumberland Counties, and some soil series perhaps should be combined. When the newer theories became known, the present report and map were too near completion to initiate studies before publication.

Over the entire area included in Montour and Northumberland Counties the climate is essentially the same, although the temperature is probably 3 to 5 degrees lower throughout the year on the mountains than in the valleys. Since the climate is nearly uniform, local differences in soils are the result of other agents or factors. Nevertheless, the common characteristics of the well-developed, well-drained soils, such as the sequence in shade of color from the A horizon to the C horizon, probably are functions primarily of climate aided by vegetation.

The forces of climate alone do not bring about the development of soils. Operating alone, they could only produce the parent material from which soils are developed. Without living organisms, soil materials would not have many of the more important soil characteristics. They would be merely residual or transported products of rock weathering, although some materials might have definite layers produced by differential weathering, leaching, eluviation, and illuviation. Plants and micro-organisms are of primary importance among the living organisms influencing soil development. Climate, since it controls to a large extent the general type of vegetation, also has an important indirect effect on the soils. Directly and indirectly, it tends to produce similar soils from different kinds of parent material, and, if it were not for the inhibiting factors of parent material, relief, drainage, and, in some places, vegetation, the same type of soil would prevail over the entire area.

Some common characteristics of the well-developed, well-drained soils may be noted. Under forest cover they all have a dark A horizon ranging from about $\frac{1}{2}$ to 2 inches thick, which contains a large proportion of organic matter. They have an A₂ horizon that is lighter in color than either the A₁ or the B horizons; a B horizon that is generally uniformly yellow, brown, or reddish brown and is heavier textured than the other horizons; and a C horizon that is generally firm, moderately heavy textured, and yellowish brown to reddish brown.

In the well-drained soils in this section, and to a smaller extent in the skeletal and immature soils, the silica content decreases and the alumina and iron oxide content increases with depth. The content of organic matter is moderately high in the A₁ horizon, less in the A₂ horizon, and decreases with depth in the B and C horizons. Nearly all of the soils are low in bases, particularly calcium and magnesium. All are low in phosphorus. Some of the soils derived from limestone material and calcareous shale, however, are relatively high in calcium compared with most of the soils of the eastern United States. They are moderately acid to slightly alkaline in the subsoil for the most part. The soils derived largely from acid shale, sandstone and quartzite, however, range from strongly to extremely acid throughout. In general, the amount of silt and sand decreases and the amount of clay increases to a depth of 24 to 30 inches. On the well-drained soils the colloid content is lowest in the A horizon and highest in the B horizon.

The foregoing paragraphs have brought out most of the characteristics that all the well-developed, well-drained soils of these counties have in common under similar climatic and vegetative conditions, irrespective of parent material or relief. These characteristics therefore can be considered as those imposed by the forces of climate and

vegetation. They are zonal characteristics, and all soils that have them are zonal soils.

Throughout most of these two counties, a striking correlation exists between the soil type and the consolidated rock underlying the parent material. The underlying rocks of this section have strongly influenced the relief, or lay of the land, which itself is important in determining the local differences in soils. For example, the extensive areas underlain by black Marcellus shale are generally low and undulating to moderately rolling; extensive areas underlain by limestone are undulating to hilly; and extensive areas underlain by gray, brown, and red acid shales are even more elevated above the valley floors and range from undulating to hilly and steep. The areas underlain by sandstone and quartzite occupy the highest elevations, have strong relief, and are more dissected than the other parts of the area.

Most of the soils of Montour and Northumberland Counties have many characteristics traceable to the underlying rocks, but a few of them are influenced in part by pre-Wisconsin glacial drift. During the glacial ages, two ice sheets, the Jerseyan and the Illinoian, entered the counties. The Jerseyan glacier apparently covered all of Montour County and all of Northumberland County except for the higher mountains in the southeastern part. The Illinoian glacier extended only as far south as the north base of Little Mountain. During the last glacial age, the Wisconsin, an ice sheet covered the region to the north but did not quite reach the northern edge of these counties. Most of the Illinoian drift is now found on the lower uplands and in valleys, where the deposits range from 5 to 20 feet thick. The deposits of Jerseyan drift are small, thin, and widely scattered; they are difficult to distinguish from residuum.

The well-drained Washington soils were developed on pre-Wisconsin till and residuum derived from limestone, sandstone, and shale. They are representative of a mature soil developed from these materials. A description of a typical profile of Washington silt loam in a cultivated field is as follows:

- A₁ 0 to 7 inches, pale-brown mellow silt loam that crumbles readily to soft granules; relatively high organic-matter supply is well incorporated with the soil; pH 6.6 (lime has been added).
- A₂ 7 to 12 inches, light yellowish-brown very friable silt loam with a weakly developed platy structure; pH 6.5.
- B₁ 12 to 28 inches, strong-brown to light reddish-brown moderately friable to firm silty clay loam of a blocky structure; aggregates easily crushed into an amorphous mass; organic matter darker and well decomposed except in a few old root channels; pH 6.3.
- B₂ 28 to 48 inches, yellowish-brown firm silty clay blocky in structure and spotted by numerous black manganese coatings; somewhat plastic when wet; pH 6.0.
- C 48 to 60 inches, pale-brown stiff blocky heavy silty clay till not readily crushed when dry; fragments of Helderberg limestone and numerous soil aggregates with manganese coatings; pH 7.5.

Most of the Washington soils overlie Helderberg limestone at various depths, although in places they overlie various other rocks.

The Allenwood soils were developed from pre-Wisconsin till and residuum of sandstone and quartzite shale derivation.

The following is a description of Allenwood silt loam occurring under a forest cover:

- A₁ 0 to 2 inches, dark-gray or almost black mass of organic matter and silty mineral particles.

- A₂ 2 to 8 inches, pale-brown very friable silt loam; pH 4.6.
- B₂₁ 8 to 15 inches, light yellowish-brown friable silt loam having a weak platy structure and containing a few subangular fragments of sandstone and shale; pH 4.3.
- B₂₂ 15 to 28 inches, yellowish-brown moderately firm but friable silty clay loam; weak coarse platy structure that crushes with moderate pressure to a soft amorphous mass; pH 4.0.
- B₂₃ 28 to 38 inches, light yellowish-brown slightly compact silty clay loam of strong nuciform structure; aggregates $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter; numerous specks of black manganese; pH 4.3.
- C 38 to 50 inches, weathered very pale-brown pre-Wisconsin glacial till; silty and moderately firm or slightly compact; numerous black manganese flakes.

In places the B horizons are somewhat reddish and more friable than those described.

The Dewart soils, developed on pre-Wisconsin till derived from the same materials as the Allenwood soils, apparently have a higher oxidized-iron content than the Allenwood soils which is indicated by the redder color of the B and C horizons. Influenced by a gravelly substratum, they are somewhat lighter in texture and structure than Allenwood soils and have very good aeration.

The intrazonal soils differ from the well-drained or zonal soils in two important particulars. At depths ranging from 15 to 30 inches, instead of the friable or moderately firm oxidized yellowish-brown or reddish-brown layer that is present in the zonal soils, there is a lighter colored layer that is mottled with gray to a certain extent. This layer has a considerable degree of cohesion; in some of the soils it is compact. The initial tendency to restricted drainage results from nearly level relief in most places, but the development of a somewhat cemented zone is the result of other factors. The soil fragments, when dry, are decidedly porous, and in some places the lower part of this grayish layer has a somewhat vesicular structure. Many of the minute openings and the joint planes have a film, or varnishlike coating, of colloidal material. This suggests that resistance to the movement of water is due to these colloids, which swell and fill the pore spaces when moisture is absorbed.

The imperfectly drained soils associated with gray sandstone and shale present numerous modifications. All, however, have these outstanding characteristics—meager organic accumulation, strong to extreme acidity, and a well-developed cemented layer. These features are not quite so pronounced in the soils that are derived from red shale and red sandstone and are even less evident in soils derived from limestone and calcareous shale. The soils derived from limestone material have the distinctly granular structure common to most soils high in lime. In addition, the accumulation of organic matter is somewhat greater and it is incorporated to greater extent with the mineral constituents of the soil.

The Watson and Warrior soils are associated with the Allenwood and Dewart soils and have developed from similar materials. Owing to moderate relief and seepage from higher lying soils, they have been impeded in their development and have somewhat impervious layers below a depth of 20 to 30 inches.

The following describes a typical profile of Watson soil (silt loam) under forest cover:

- A₀ 0 to 2 inches, a mat of roots and organic matter.
- A₁ 2 to 6 inches, light brownish-gray friable silt loam; contains considerable organic matter that is fairly well incorporated with the soil.

- B, 6 to 14 inches, light yellowish-brown friable silty clay loam; crumbles readily into a fine amorphous mass; a few faint gray mottlings in the lower part; pH 4.5.
- B, 24 to 38 inches, mottled yellowish gray and weak-yellow slightly compact silty clay loam with a platy structure; some black manganese flakes scattered throughout; material readily crushed; colloidal shiny coating on the surfaces of the small fragments; pH 4.5.
- C 38 to 100 inches, pale-brown silty weathered pre-Wisconsin till, moderately firm but friable; black manganese streaks plentiful; angular fragments of shale and sandstone mixed with the finer textured material in the till and to a variable extent in the overlying soil layers; pH 4.2.

The imperfectly drained soils on the stream terraces are less well drained than the Watson and Warrior soils. They owe their restricted drainage largely to their occurrence on almost level areas. Some compaction and cementation has also occurred as a result of the fluctuation of the water table.

The poorly drained soils are restricted in their development by a high but fluctuating water table. The variegated colors result from poor aeration and only partial oxidation of the iron and aluminum.

All of the soils on the flood plains are young, and but little profile development has taken place. They are therefore azonal soils. The high-bottom phases are so infrequently flooded, however, that the forces of climate and vegetation acting upon the soil have caused a translocation of a considerable quantity of readily soluble material and fine insoluble material downward to form a somewhat heavier but still immature B horizon.

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the [USDA Section 508 Coordination Team](#).

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotope, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

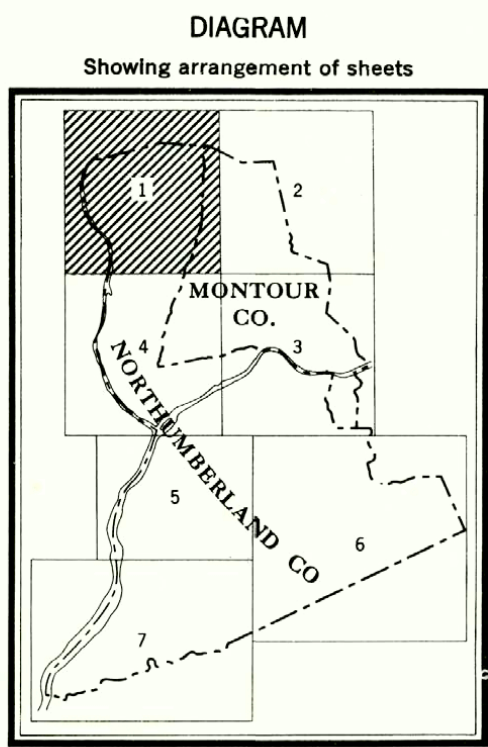
To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

- (1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;
- (2) fax: (202) 690-7442; or
- (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

SUPPLEMENT TO THE SOIL MAP OF MONTGOMERY AND NORTHUMBERLAND COUNTIES, PA. SHOWING IMPORTANT CHARACTERISTICS OF THE SOILS

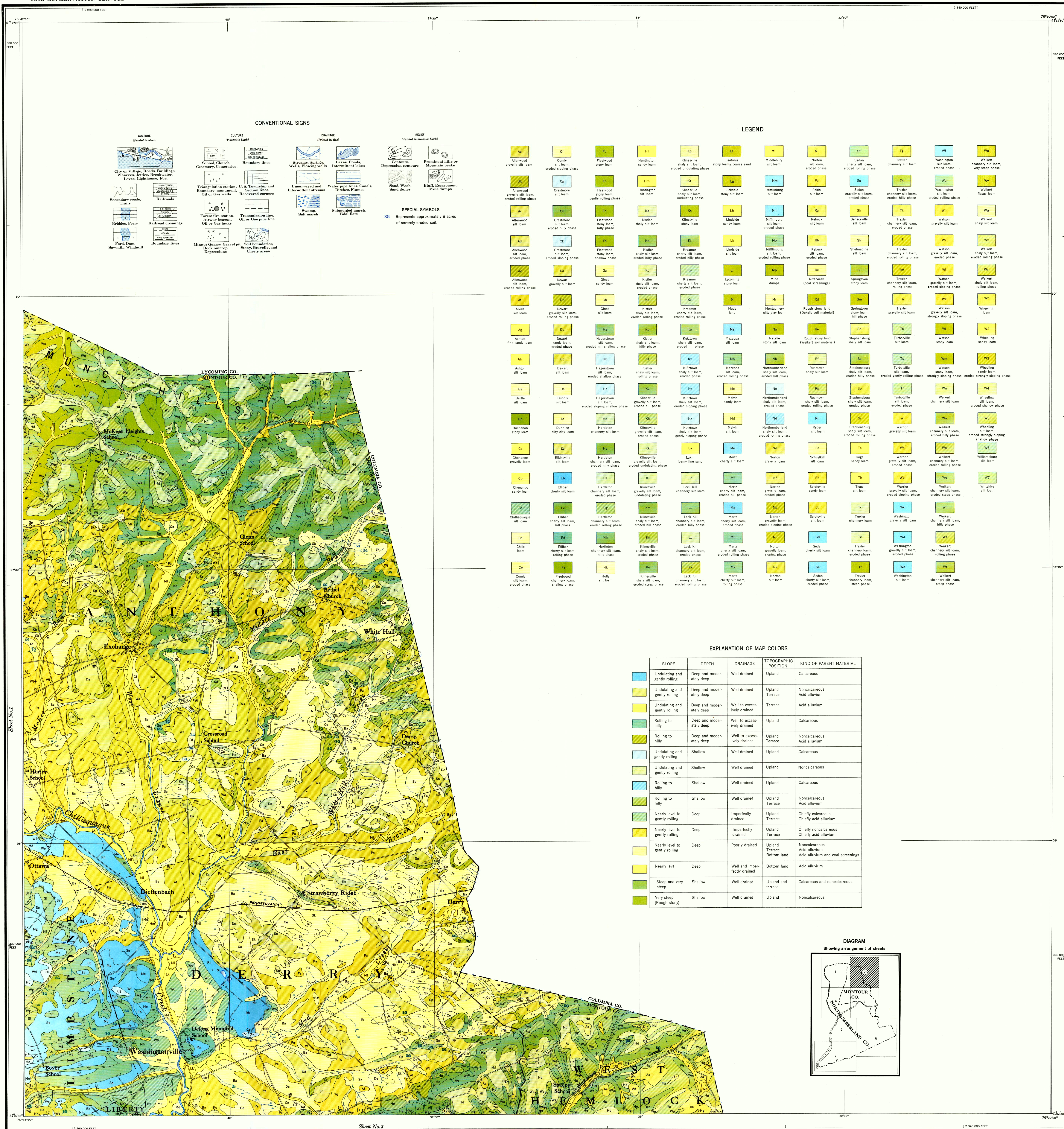
Soils	Map symbol	Topography and physio-graphic position	Dom-inant slope range	General drainage condition	Surface soil color	Subsoil			Parent soil material		Parent rock	Relative depth to bedrock
						Color	Consistence	Reaction	Kind	Reaction		
Allenwood gravelly silt loam.....	Aa	Gently rolling uplands.....	Percent 3-12	Good.....	Light brown.....	Yellowish-brown.....	Friable.....	Very strongly acid.....	Pre-Wisconsin till and residuum.....	Very strongly acid.....	Gray acid shale, sandstone, and quartzite.....	Deep.....
Eroded rolling phase.....	Ab	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Allenwood silt loam.....	Ac	Gently rolling uplands.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Ad	do.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Ae	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Alvira silt loam.....	Av	Undulating uplands.....	2-7	Imperfect.....	Dark grayish-brown.....	Mottled yellowish-brown and light gray.....	Firm.....	do.....	do.....	do.....	do.....	Do.....
Ashton fine sandy loam.....	Ao	Nearly level high bottoms.....	0-3	Good.....	Brown.....	Moderate to strong brown.....	Friable.....	Slightly to moderately acid.....	Alluvium.....	Slightly acid.....	Sandstone, shale, and limestone.....	Do.....
Ashton silt loam.....	Au	do.....	0-3	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Bartle silt loam.....	Ba	Nearly level terraces.....	0-3	Poor.....	Light gray.....	Mottled, predominantly gray.....	Slightly plastic.....	Strongly to very strongly acid.....	Older alluvium.....	Strongly to very strongly acid.....	Sandstone and shale and some limestone.....	Do.....
Buchanan silt loam.....	Bb	Sloping uplands.....	4-20	Imperfect.....	Grayish-yellow.....	Mottled, yellowish-brown and light gray.....	Friable.....	Extremely acid.....	Colluvium.....	Extremely acid.....	Primarily sandstone.....	Do.....
Chenango gravelly loam.....	Ca	Nearly level terraces.....	0-8	Good.....	Grayish-brown.....	Yellowish-brown.....	do.....	Very strongly acid.....	Alluvium (gravel within 36 inches).....	Very strongly acid.....	Gray acid sandstone, shale, and quartzite.....	Do.....
Chenango sandy loam.....	Cb	do.....	0-8	do.....	Light brown.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Chillisquaque silt loam.....	Cc	do.....	0-5	Imperfect.....	Dark grayish-brown.....	Mottled, yellowish-brown and light gray.....	Firm.....	Neutral to medium acid.....	Colluvium over lacustrine deposits.....	Strongly acid.....	Upper deposit from limestone, lower from acid rocks.....	Do.....
Chilo loam.....	Cd	do.....	0-3	Very poor.....	Dark gray to black.....	Mottled, predominantly gray.....	Slightly plastic.....	Strongly to very strongly acid.....	Alluvium (gravel below 36 inches).....	Strongly to very strongly acid.....	Sandstone and shale.....	Do.....
Conly silt loam.....	Ce	Undulating uplands.....	2-6	Imperfect.....	Grayish-brown.....	Mottled, yellowish brown and light gray.....	Friable.....	Strongly acid.....	Pre-Wisconsin till and residuum.....	Strongly acid.....	Dark gray or black acid shale.....	Moderate.....
Eroded rolling phase.....	Cf	Sloping uplands.....	6-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Crestmore silt loam.....	Cg	Undulating uplands.....	3-8	Good.....	Brown.....	Pale reddish brown to strong brown.....	Firm.....	Slightly acid or neutral.....	do.....	Slightly acid to alkaline.....	Primarily limestone.....	Shallow.....
Eroded hilly phase.....	Ch	Hilly uplands.....	15-30	Well drained.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded sloping phase.....	Ci	Sloping uplands.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Dewart gravelly silt loam.....	Da	Undulating uplands.....	3-12	Good.....	Light brown.....	Yellowish brown to red-dish brown.....	Friable.....	Very strongly to extreme-ly acid.....	do.....	Very strongly to extreme-ly acid.....	Gray acid shale, sandstone, and quartzite.....	Deep.....
Eroded rolling phase.....	Db	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Dewart sandy loam, eroded phase.....	Dc	Undulating uplands.....	4-10	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Dewart silt loam.....	De	do.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Dubois silt loam.....	Dd	Gently sloping terraces.....	2-7	Poor.....	Grayish-brown.....	Mottled, yellowish brown and light gray.....	Slightly plastic.....	do.....	Lacustrine deposits.....	Strongly acid.....	Ice sheet deposits.....	Do.....
Dunning silty clay loam.....	Df	Nearly level bottoms.....	0-3	Very poor.....	Dark gray to black.....	Mottled, predominantly gray.....	Plastic.....	Moderately to strongly acid.....	Alluvium.....	Moderately to strongly acid.....	Sandstone, shale, and lime-stone.....	Do.....
Elkinsville silt loam.....	Ea	Gently sloping terraces.....	0-5	Good.....	Pale brown.....	Yellowish brown.....	Friable.....	Strongly acid.....	do.....	Moderately acid.....	Acid gray sandstone and shale and some limestone.....	Do.....
Elliber cherty silt loam.....	Eb	Sloping uplands.....	4-12	do.....	Weak yellow.....	Weak to dusky yellow.....	Loose.....	Extremely acid.....	Residuum.....	Extremely acid.....	Cherty limestone.....	Do.....
Hill phase.....	Ec	Hilly uplands (single slopes).....	20-40	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Rolling phase.....	Ed	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Fleetwood channery loam, shallow phase.....	Fa	Gently rolling uplands.....	5-12	Excessive.....	Grayish-brown.....	Yellowish brown.....	Friable.....	do.....	do.....	do.....	do.....	Do.....
Fleetwood stony loam.....	Fb	Rolling uplands.....	12-20	Somewhat excessive.....	do.....	do.....	do.....	do.....	Pre-Wisconsin till and residuum.....	Very strongly to ex-tremely acid.....	Acid gray quartzite.....	Very shallow.....
Gently rolling phase.....	Fc	Gently rolling uplands.....	5-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Deep.....
Hilly phase.....	Fd	Hilly uplands.....	20-35	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Shallow phase.....	Fe	Rolling to hilly uplands.....	12-35	Excessive.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Ginat sandy loam.....	Ga	Nearly level terraces.....	0-3	Poor.....	Mottled, predominantly gray to dark gray.....	Mottled, predominantly gray.....	Friable but sticky.....	Very strongly to extreme-ly acid.....	Alluvium (gravel below 36 inches).....	do.....	Sandstone and shale.....	Deep.....
Ginat silt loam.....	Gb	do.....	0-3	do.....	do.....	do.....	Plastic.....	do.....	do.....	do.....	do.....	Do.....
Hagerstown silt loam.....	Hb	Hilly uplands (single slopes).....	15-40	Well drained.....	Moderate brown.....	Strong brown to weak reddish brown.....	Very firm.....	Slightly acid.....	Residuum.....	Slightly acid.....	Gray limestone.....	Very shallow.....
Eroded rolling phase.....	Hc	Gently sloping uplands.....	3-8	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded sloping shallow phase.....	Hd	Sloping uplands.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Hardieton channery silt loam.....	He	Undulating to moderately rolling uplands.....	3-12	do.....	Pale brown.....	Yellowish-brown.....	Friable.....	Very strongly acid.....	Pre-Wisconsin till and residuum.....	Very strongly acid.....	Acid gray sandstone, shale, and quartzite.....	Shallow.....
Eroded hilly phase.....	Hf	Hilly uplands.....	20-40	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Hg	Undulating uplands.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Hi	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Hilly phase.....	Hj	Hilly uplands.....	20-40	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Holly silt loam.....	Hk	Nearly level bottoms.....	0-3	Poor.....	Dark gray.....	Mottled, predominantly gray.....	do.....	Medium to strongly acid.....	Alluvium.....	Medium to very strongly acid.....	do.....	Do.....
Huntington sandy loam.....	Hi	do.....	0-3	Good.....	Brown.....	Moderate brown.....	do.....	Slightly to medium acid.....	do.....	Slightly acid to neutral.....	Limestone and calcareous shale.....	Do.....
Huntington silt loam.....	Ha	do.....	0-3	do.....	do.....	do.....	Firm.....	Medium acid to neutral.....	do.....	do.....	do.....	Do.....
Kistler shaly silt loam.....	Ka	Undulating uplands.....	2-12	Somewhat excessive.....	Brown to yellowish brown.....	Yellowish brown.....	Friable.....	Strongly acid.....	Pre-Wisconsin till and residuum.....	Strongly acid.....	Dark gray or black un-weathered acid shale.....	Very shallow.....
Eroded hilly phase.....	Kb	Hilly uplands.....	20-40	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Kc	Undulating uplands.....	2-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Kd	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Hilly phase.....	Ke	Hilly uplands.....	20-40	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Rolling phase.....	Kf	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Kilneville gravelly silt loam.....	Kg	Hilly uplands (single slopes).....	20-35	Good.....	Dark reddish brown.....	Dark reddish brown.....	do.....	Strongly to very strongly acid.....	do.....	Strongly to very strongly acid.....	Unweathered acid red shale.....	Do.....
Eroded phase.....	Kh	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded undulating phase.....	Ki	Undulating uplands.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Undulating phase.....	Kj	do.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Kilneville shaly silt loam.....	Kl	Hilly uplands (single slopes).....	20-35	Excessive.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Km	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded steep phase.....	Kn	Steep uplands.....	35-50	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Erode undulating phase.....	Kp	Undulating uplands.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Undulating phase.....	Kq	do.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Kilneville stony loam.....	Ks	Steep uplands.....	5-60	do.....	do.....	No subsoil (bedrock ex-posed on large areas).....	do.....	do.....	do.....	do.....	do.....	Do.....
Kreamer cherty silt loam.....	Kr	Hilly uplands.....	15-25	Imperfect.....	Yellowish brown.....	Light yellowish brown.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Kv	Undulating uplands.....	2-8	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Kw	Rolling uplands.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Kutstov shaly silt loam.....	Kv	Hilly uplands (single slopes).....	20-35	Good.....	Brownish gray.....	do.....	do.....	Slightly acid to neutral.....	do.....	Slightly alkaline.....	Calcareous shale.....	Very shallow.....
Eroded phase.....	Kx	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded sloping phase.....	Ky	Sloping uplands.....	8-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Gently sloping phase.....	Kz	Gently sloping uplands.....	4-8	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Lakin loamy fine sand.....	La	Undulating terraces.....	3-12	do.....	Light yellowish brown.....	do.....	do.....	Strongly to very strongly acid.....	Aeolian sand.....	Strongly to very strongly acid.....	Acid materials.....	Deep.....
Leek Kill channery silt loam.....	Lb	Uplands.....	3-12	do.....	Brown.....	Reddish brown or reddish yellow.....	do.....	Strongly to extremely acid.....	Pre-Wisconsin till and residuum.....	Strongly to extremely acid.....	Red, yellow, and gray acid shale.....	Shallow.....
Eroded hilly phase.....	Lc	Hilly uplands.....	20-35	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Ld	Undulating uplands.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Le	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Leetonia stony loamy coarse sand.....	Lf	Undulating to rolling up-lands.....	5-25	Excessive.....	Light gray.....	Yellowish brown.....	do.....	Extremely acid.....	Residuum.....	Extremely acid.....	Acid gray sandstone and quartzite.....	Do.....
Lekdale stony silt loam.....	Lg	Gently sloping uplands.....	2-6	Poor.....	Gray.....	Mottled, predominantly gray.....	Slightly plastic.....	Very strongly to ex-tremely acid.....	Residual colluvium.....	Very strongly to ex-tremely acid.....	Primarily sandstone.....	Deep.....
Lindside sandy loam.....	Li	Nearly level bottoms.....	0-3	Imperfect.....	Grayish brown.....	Mottled, yellowish brown and light gray.....	do.....	Medium to strongly acid.....	Alluvium.....	Medium to strongly acid.....	Sandstone, shale, and lime-stone.....	Do.....
Lindside silt loam.....	Lk	do.....	0-3	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Lycoming stony loam.....	Ll	Strongly sloping uplands.....	10-25	Good.....	Yellowish brown.....	Yellowish brown.....	Friable.....	Extremely acid.....	Colluvium.....	Extremely acid.....	Primarily sandstone.....	Do.....
Made land.....	M	Usually level; variable position.....	0-3	Variable.....	Variable.....	Variable.....	Variable.....	Variable.....	Variable.....	Variable.....	Variable.....	Varia-ble.....
Mazeppa silt loam.....	Ma	Undulating uplands.....	3-12	Good.....	Weak reddish brown.....	Reddish brown.....	Friable.....	Medium to strongly acid.....	Pre-Wisconsin till and residuum.....	Medium to strongly acid.....	Calcareous red shale.....	Deep.....
Eroded rolling phase.....	Mb	Rolling uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Meivin sandy loam.....	Mc	Nearly level bottoms.....	0-3	Poor.....	Dark gray.....	Mottled, predominantly gray.....	Slightly plastic.....	Medium acid to mildly alkaline.....	Alluvium.....	Slightly acid to neutral.....	Sandstone, shale, limestone.....	Do.....
Mevin silt loam.....	Md	do.....	0-3	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Mertis cherty silt loam.....	Me	Gently undulating up-lands.....	3-8	Somewhat excessive.....	Grayish brown.....	Yellowish brown.....	Friable.....	Very strongly to ex-tremely acid.....	Pre-Wisconsin till and residuum.....	Strongly acid.....	Cherty limestone.....	Do.....
Eroded hill phase.....	Mf	Hilly uplands (single slopes).....	15-30	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Mg	Gently undulating up-lands.....	3-8	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Mh	Rolling uplands.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Rolling phase.....	Mi	do.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Middlebury silt loam.....	Ml	Nearly level bottoms.....	0-3	Imperfect.....	do.....	Mottled, yellowish brown and light gray.....	do.....	Medium to very strongly acid.....	Alluvium.....	Medium to very strongly acid.....	Acid gray sandstone, shale, and quartzite.....	Do.....
Mifflinburg silt loam.....	Mm	Gently sloping uplands.....	3-8	Good.....	do.....	Yellowish brown.....	do.....	Medium acid.....	Pre-Wisconsin till and residuum.....	Neutral to mildly alka-line.....	Olive gray calcareous shale.....	Do.....
Eroded phase.....	Mn	do.....	3-8	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Mo	Rolling uplands.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Mine dumps.....	Mp	Variable.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Montgomery silty clay loam.....	Ma	Nearly level terraces.....	0-3	Poor.....	Gray to black.....	Mottled, predominantly gray.....	Plastic.....	Neutral to weakly alka-line.....	Artificial.....	Stream deposits.....	Limestone and calcareous shale.....	Do.....
Natalie stony silt loam.....	Na	Undulating uplands.....	4-10	Imperfect.....	Grayish brown.....	Mottled, yellowish brown and light gray.....	Firm.....	Extremely acid.....	Pre-Wisconsin till and residuum.....	Very strongly to ex-tremely acid.....	Acid gray quartzite.....	Do.....
Northumberland shaly silt loam.....	Nb	Hilly uplands (single slopes).....	15-35	Somewhat excessive.....	Dusky reddish brown.....	Pale reddish brown.....	Friable.....	Slightly acid.....	do.....	Mildly alkaline.....	Calcareous red shale.....	Very shallow.....
Eroded phase.....	Nc	Gently undulating up-lands.....	3-8	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded rolling phase.....	Nd	Rolling uplands.....	8-15	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Norton gravelly loam.....	Ne	Undulating uplands.....	3-12	Good.....	Brown or pale reddish brown.....	Reddish brown.....	do.....	Very strongly acid.....	do.....	Very strongly acid.....	Acid red shale.....	Deep.....
Eroded phase.....	Nf	do.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded sloping phase.....	Ng	Sloping uplands.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Sloping phase.....	Nh	do.....	12-20	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Norton silt loam.....	Ni	Undulating uplands.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Eroded phase.....	Nj	do.....	3-12	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.....
Pekin silt loam.....	Pa	Nearly level terraces.....	0-									



SOIL MAP
 MONTOUR AND NORTHUMBERLAND COUNTIES
 PENNSYLVANIA
 SHEET NO. 2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PENNSYLVANIA STATE COLLEGE
SCHOOL OF AGRICULTURE AND EXPERIMENT STATION



J. Kenneth Ableiter, Chief Soil Correlator.
C. P. Barnes, Chief Analyst, Soil Uses and Productivity.
Earl D. Fowler, Principal Soil Correlator, Northern States.
Correlation and inspection by W. J. Latimer, Senior Soil Scientist.
Soils surveyed 1941-42 by David Taylor, Soil Conservation Service,
in Charge, S. R. Bacon, Bureau of Plant Industry, Soils, and
Agricultural Engineering, and L. G. Yearick, Pennsylvania State College.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1933. J. 254775

Scale 1:24,000

0 1 2 Miles

5000 0 5000 10000 Feet

Base map compiled by Soil Conservation Service for the Division of Soil Survey, Cartographic Section, H. W. Whitlock, Engineer, in Charge.
Polyconic projection, 1927 North American datum.
Horizontal control from USGS and USC&GS.
10000 foot grid based on Pennsylvania (North) rectangular coordinate system.

SOIL MAP
MONTOUR AND NORTHUMBERLAND COUNTIES
PENNSYLVANIA
SHEET NO.3

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PENNSYLVANIA STATE COLLEGE
SCHOOL OF AGRICULTURE AND EXPERIMENT STATION



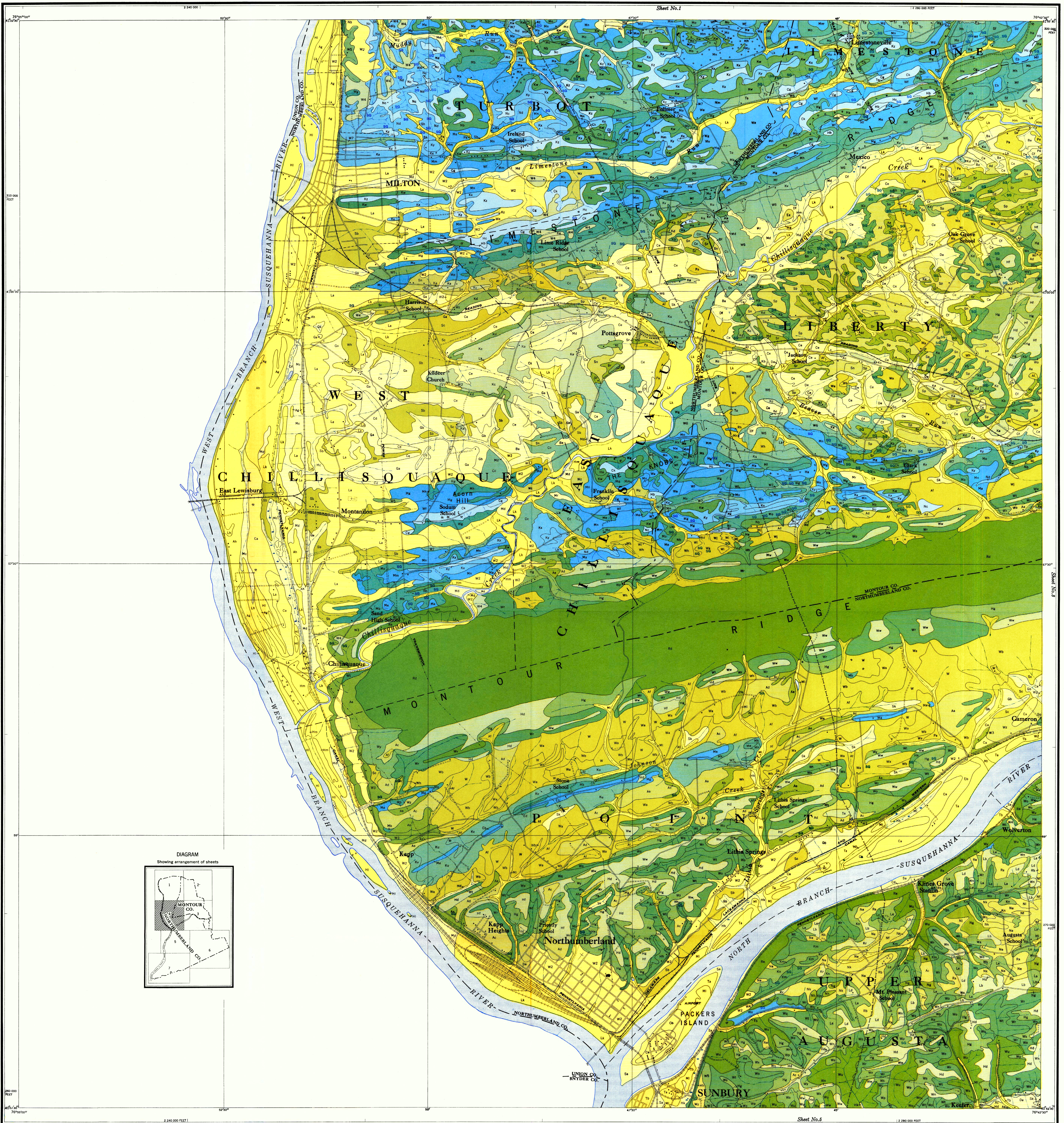
J. Kenneth Ables, Chief Soil Correlator.
C. P. Barnes, Chief Analyst, Soil Uses and Productivity.
Earl D. Fowler, Principal Soil Correlator, Northern States.
Correlation and inspection by W. J. Latimer, Senior Soil Scientist.
Soils mapped 1941-42 by David Taylor, Soil Conservation Service.
In Charge, S. R. Bacon, Bureau of Plant Industry, Soils, and
Agricultural Engineering, and L. G. Yeaford, Pennsylvania State College.

U. S. GOVERNMENT PRINTING OFFICE: 1939. 1-24715

Scale 1:24,000
5000 0 5000 10000 Feet

See sheet No. 2 for Alphabetical Legend, Explanation of Map Colors,
Conventional Signs, and Diagram showing arrangement of sheets.

Base map compiled by Soil Conservation Service for
the Division of Soil Survey, Cartographic Section,
H. W. Whitlock, Engineer in Charge.
Polyconic projection, 1927 North American datum.
Horizontal control from USGS and USCGS.
10,000 foot grid based on Pennsylvania (North) rectangular
coordinate system.

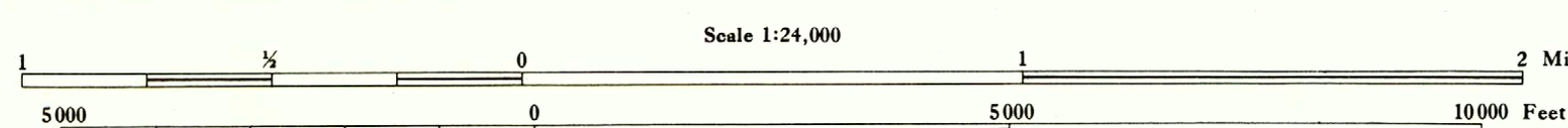


SOIL MAP
MONTOUR AND NORTHUMBERLAND COUNTIES
PENNSYLVANIA
SHEET NO. 5



J. Kenneth Ablester, Chief Soil Correlator.
C. P. Barnes, Chief Analyst, Soil Uses and Productivity.
Earl D. Fowler, Principal Soil Correlator, Northern States.
Correlation and Inspection by W. J. Latimer, Senior Soil Scientist.
Soils surveyed 1941-42 by David Taylor, Soil Conservation Service,
in Charge, S. R. Bacon, Bureau of Plant Industry, Soils,
Agricultural Engineering, and L. G. Yearick, Pennsylvania State College.

U.S. GOVERNMENT PRINTING OFFICE: 1955. 1:254715



See sheet No. 2 for Alphabetical Legend, Explanation of Map Colors,
Conventional Signs, and Diagram showing arrangement of sheets.

Base map compiled by Soil Conservation Service for
the Division of Soil Survey, Cartographic Section,
H. W. Whitlock, Engineer, in Charge.
Polyconic projection, 1927 North American datum.
Horizontal control from USGS and USCGS.
10,000 foot grid based on Pennsylvania (North) rectangular
coordinate system.

